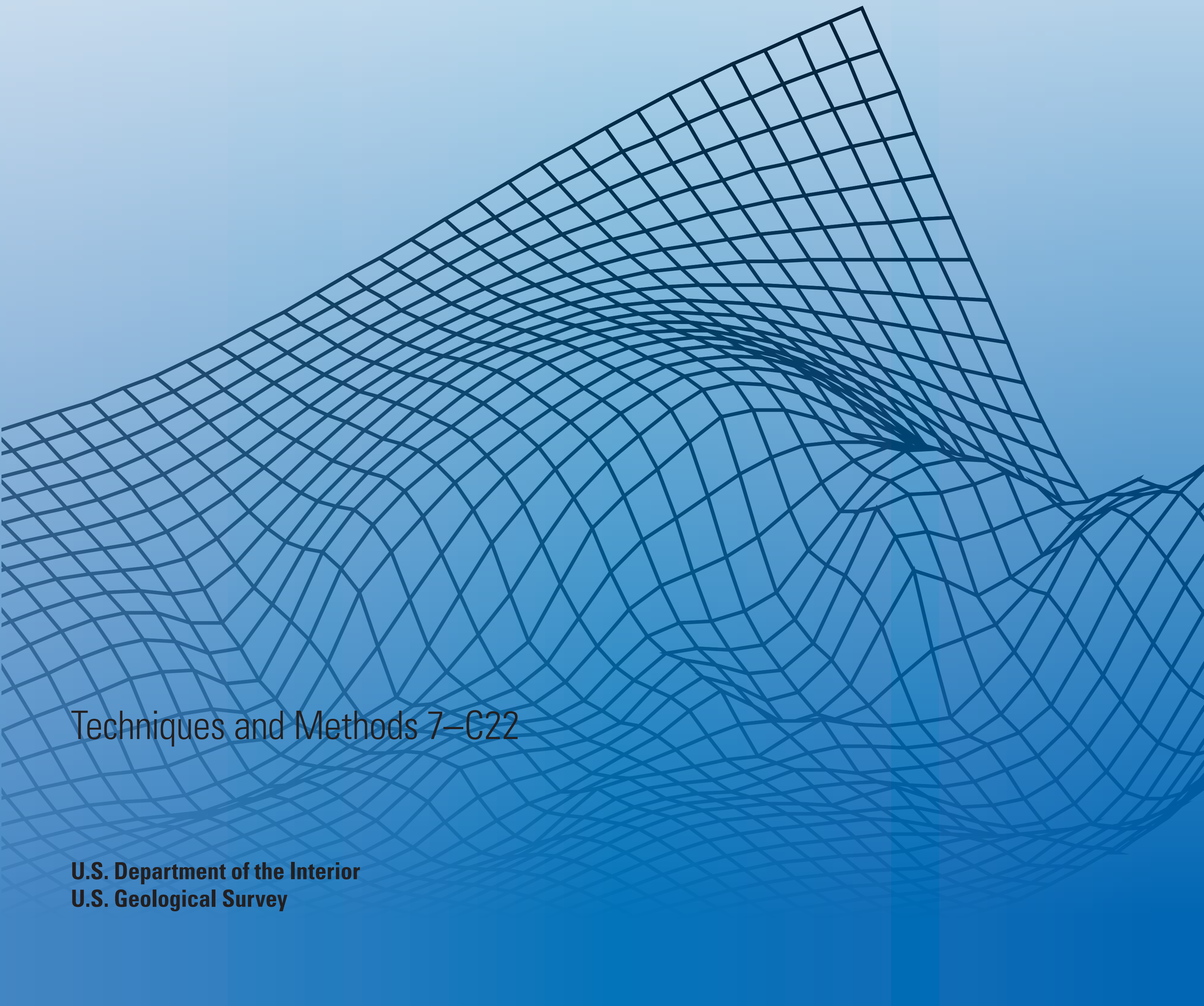
Prepared in cooperation with the California Department of Water Resources

User's Manual for the Draper Climate-Distribution Software Suite with Data-Evaluation Tools



Techniques and Methods 7–C22

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Contents

Figures

Tables

Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as

$$°C = (°F – 32) / 1.8.$$

Abbreviations

σ	sigma
CSV	comma separates value
Draper Suite	Draper Climate-Distribution software suite
DTR	daily temperature range
GIS	Geographic Information Systems
HRU	hydrologic response unit
MB	megabyte
MHz	megahertz
PC	personal computer
PPT	daily precipitation
PRISM	Parameter-elevation Regressions on Independent Slopes Model
PRMS	Precipitation-Runoff Modeling System
PS	postscript
RAM	random access memory
SP	Service Pack
TMAX	maximum daily temperature
TMIN	minimum daily temperature
USGS	U.S. Geological Survey

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Abstract

Development of a time series of spatially distributed climate data is an important step in the process of developing physically based environmental models requiring distributed inputs of climate data beyond what is available from observations collected at climate stations. To prepare inputs required for model-mapping units across the study area, climate data (temperature and precipitation) are distributed by combining data from gridded surfaces of mean-monthly climate-data values with (often) widely spaced daily point observations. Examples of climate-data files used to develop PRMS-formatted input files for the Merced River Basin Precipitation-Runoff Modeling System (PRMS) are included in this manual.

The Draper Climate-Distribution Software Suite (Draper Suite) consists of the Draper climate-distribution program (Draper) and several supporting pre- and post-processing applications. Draper combines spatially distributed input in the form of monthly averaged values for precipitation, maximum temperature, and minimum temperature with daily observed data from climate stations to estimate distributed climate-data values at predefined locations across a study area (typically a drainage basin) on a daily time step. Alternative methods are used when station data are limited or missing for a particular day. Draper uses a set of required and optional input and output files with defined formats and naming conventions. A shell application also is available to manage multiple runs of the Draper application.

Other applications in the Draper Suite include (1) a tool to find and interactively remove outliers in the input data, (2) a tool to check and enforce a minimum daily temperature range, and (3) a tool to view output diagnostic information as time-series graphs. These tools can be used iteratively to evaluate and improve the results from Draper as part of a workflow involving physically based environmental models, such as the Precipitation-Runoff Modeling System (PRMS).

Introduction

The Draper Climate-Distribution Software Suite (Draper Suite) is designed to assist the operator in the preparation of large climate datasets that will be used to drive physically based environmental models. Draper Suite is centered around the Draper climate-distribution software (Draper), originally written by U.S. Geological Survey (USGS) scientist Michael Dettinger and published in 2005 as part of the final report on the Feather River Basin Precipitation-Runoff Modeling System (Koczot and others, 2005) in cooperation with the California Department of Water Resources Snow Surveys program. Although originally written to assemble time-series datasets (Koczot and others, 2005) used to drive PRMS, Draper may be applied to generate data for any physically based model.

The version of Draper described here was upgraded from the original to (1) generate daily temperature distributions and (2) remove hard-wired limitations that added difficulty to the task of interfacing with other software. To accomplish verification and validation of the new features and changes, various tools were added to analyze and improve input and output. The collection of tools, along with Draper, was released to the cooperator as Draper Suite.

Draper Suite estimates and distributes climate data by combining daily point observations that are often widely spaced, with data from interpolated surfaces of mean-monthly climate-data values. These are used to create estimates on a daily time step for each model-mapping unit. Draper Suite utilizes inputs of precipitation and maximum and minimum temperatures, collectively referred to as climate data, from observation stations in or near the study area. It then performs a spatial distribution of the climate data by estimating values at unmeasured points across the study area. The resulting distributed climate data can then be fed into, for example, a precipitation-runoff model to produce a streamflow forecast (fig. 1).

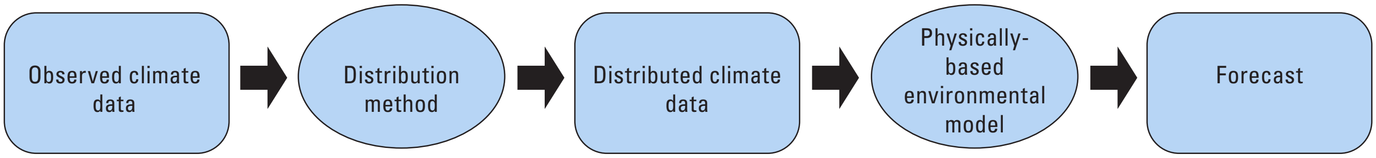


Figure 1. Example of general workflow to create input climate datasets to drive physically based environmental model forecasting.

Examples of files necessary to develop climate data for the Merced River Basin PRMS (K.M. Koczot, U.S. Geological Survey, written commun., 2018) are included throughout this manual. The PRMS model-mapping units are called hydrologic response units (HRUs). In the examples we use values from interpolated climate surfaces from the Parameter-elevation Regressions on Independent Slopes Model (PRISM; PRISM, 2015; Daly and others, 1994; Di Luzio and others, 2008), but interpolated surfaces may be from other sources if they are in the required input format. Each PRISM surface spatially defines values for a climate variable, offers full coverage of the study area, and accounts for topographic effects, including rain shadow. See the PRISM website for available date ranges and products (http://prism.oregonstate.edu/normals/).

Draper is a Windows console application that can be run directly from an executable or by running DraperManager, which acts as a shell that calls Draper, but adds several features such as merging and comparing output from multiple Draper runs. Data-evaluation tools also are included in this release to facilitate quality control of input measurements and outputs.

The Draper Suite consists of the Draper climate-distribution software and a number of supporting pre- and post-processing applications, including OutlierFinder (aids in finding and removing outliers in the input data), PrmsDiff (tracks changes to the input data), DtrChecker (enforces a minimum daily temperature range), and the Diagnostic Spreadsheet and Gr Diagnostic Viewer (identifies extreme values and provides graphical visualizations of the Draper output). These tools can be used to iteratively evaluate and improve the results from Draper to prepare inputs for precipitation-runoff models such as PRMS.

Draper Suite is sometimes provided as part of a "Draper release package" that includes input for a certain study area and time period. A cooperator who is interested in that study area can obtain the release package and use it to produce output or to serve as a starting point for future runs.

Software Design

The Draper climate-distribution software is the centerpiece of the Draper Suite dataflow-software structure (fig. 2). Supporting software include data-evaluation tools (OutlierFinder, PrmsDiff, and DraperManager) used to facilitate quality control of the measured climate data that are read into Draper and data-evaluation tools used to assess Draper output (DtrChecker, Diagnostic Spreadsheet, and Gr Diagnostic Viewer). These tools may be used iteratively and tested in the physically based environmental model as passes are made from measured data to output. These tools are further described in the section "Evaluating and Improving Results." Other supporting software includes Geographic Information System (GIS; Environmental Systems Research Institute, 1992) scripts that process PRISM gridded data and CalcSigma software (appendix 1) that prepares input files of standard deviations of temperature from PRISM data for climate-data output files and statistical evaluations at HRU centroid locations and climate-station locations (fig. 2).

Draper generates a PRMS-formatted input file of time-series climate data (Draper's "climate-data output file"), but Draper may be used to generate time-series data for any physically based modeling application. Draper Suite has been successfully applied to generate files of time-series climate data for PRMS models of river basins of Sierra Nevada, California, including the Feather (K.M. Koczot, U.S. Geological Survey, written commun., 2018), Kings (K.M. Koczot, U.S. Geological Survey, written commun., 2018), Merced (K.M. Koczot, U.S. Geological Survey, written commun., 2018), Tuolumne (K.M. Koczot, U.S. Geological Survey, written commun., 2018), Yuba (K.M. Koczot, U.S. Geological Survey, written commun., 2018), and the Klamath River Basin in Oregon (J.C. Risley, U.S. Geological Survey, written commun., 2018).

For the Draper Suite directory architecture and contents, including executables, source code, and locations of input and output files, see appendix 2. Appendix 3 describes status, warning, and error messages that are written to the display screen and log files, which aid in the iterative process to minimize errors and anomalies in data files to run in the physically based environmental model.

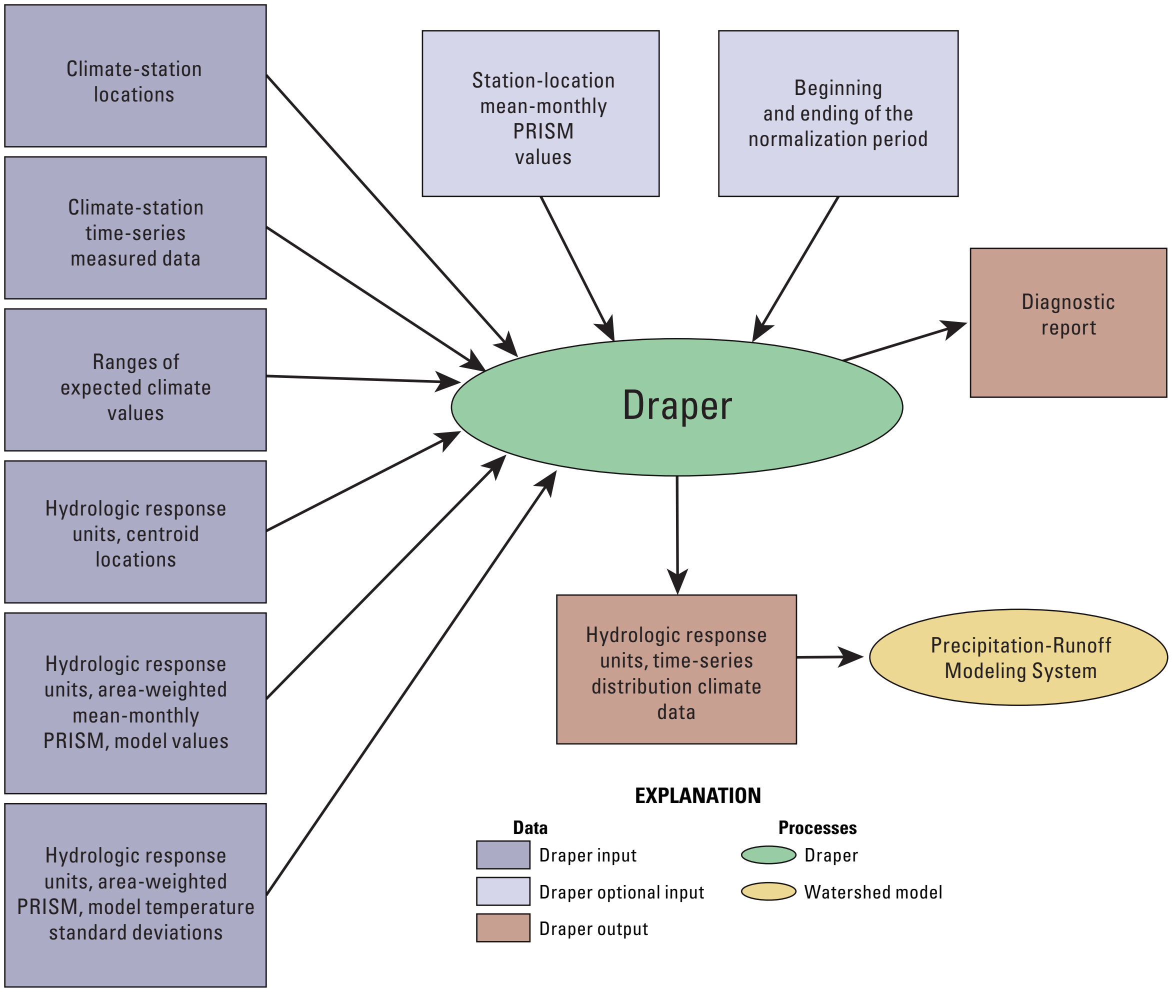


Figure 2. Data flow of the Draper climate-distribution software including input data, output data, and diagnostic information. (HRUs are Hydrologic Response Units. PRMS is Precipitation-Runoff Modeling System. PRISM is Parameter-elevation Regressions on Independent Slopes Model.)

Purpose and Scope

This report describes Draper Suite version 20170327 and serves as the user manual. Examples from the application of Draper Suite for the Merced River Basin PRMS (Koczot and others, 2018b) are included throughout this report. This report first describes how to install Draper Suite, including hardware and software requirements. An overview of the various forms of the executable and graphical frames is presented in the section "Implementation." Input files to Draper are described in the section "Input Files." The unique output files produced by Draper or DraperManager are described in the section "Output Files." The next section, "Evaluating and Improving Results," demonstrates how to apply data-evaluation tools, handle problems that may occur, and modify input files to improve results. The eight appendixes contain (1) guidance for using supporting software to make standard-deviation input files required for Draper to compute temperatures; (2) descriptions of the directory architecture and file locations; (3) explanations of status, warning, and error messages; (4) instructions on how to write customized batch files for command-line operation and options; (5) examples of input file formats; (6) the mathematical theory underpinning the Draper code; (7) examples of output files including the climate-data output file and diagnostic information; and (8) tips on changing Draper input to improve results.

Installation Instructions

Draper Suite can be installed in any location by copying the executable files to a database location of interest.

Distribution Package

Draper Suite is distributed as a compressed file for installation on a Windows personal computer (PC) platform. About 190 megabytes (MB) of disk space is required for installation. This total includes approximately 30 MB for tools and documentation and an example Draper setup for the Merced River Basin PRMS application. Of the 160 MB, about 100 MB are required to hold output data from the example model runs.

The Draper executable was compiled using Intel® Visual Fortran Compiler XE 14.0.2.176, IA-32 on a PC platform. The operation is explained in the sections "Implementation" and "Evaluating and Improving Results." The purposes of the various top-level subdirectories are as follows.

- DRAPER_RELEASE_20170327\ contains the executables used to run Draper and perform data checking, and it contains the following subdirectories:
  - DRAPER_SRC_EXE_20170327\ contains source code and copies of batch files and executables.
  - Gr\ contains graphing tools (Donovan, 2010).
  - MERCED\ contains the workspaces, subfolders, and files needed to generate precipitation and maximum and minimum temperatures for the Merced study area (appendix 2).
  - OutlierFinder\ contains source code and the executable to run the data-evaluation tool "OutlierFinder."

Hardware Requirements

Draper was developed for Windows-based personal computers with either Windows 10 (8u51 and above), Windows 8, Windows 7 Service Pack (SP)1, or Windows Vista SP2. The required hardware must have at least 128 MB of random-access memory (RAM), a Pentium 2 266-megahertz (MHz) processor, and a 24-bit color graphics card (for graphical tools only). Additional memory and processor capacity are recommended.

Hardware requirements, however, also depend on the size of the datasets being used. As an example, a configuration with about 65 years of input data at 20 stations and about 650 HRUs requires about 1 MB of memory to run Draper and about 10 MB of memory to view the output data or the diagnostic output in a text editor. The Gr diagnostic viewer requires about 250 MB of memory to view the output, whereas the OutlierFinder tool requires 650 MB of memory to view and edit the input data.

Software Requirements

Draper Suite requires Java 7 or higher. Check with your system administrator before attempting to install Java; it is freely available from the official web page (https://www.java.com/en/). Geographic Information Systems software may be required to preprocess PRISM data for Draper input.

Installation of Pre- and Post-Processing Applications

Draper can be installed in any location by copying the executable files to the location. OutlierFinder is installed by copying the \OutlierFinder\ directory and the accompanying Gr\ directory to the desired location (for Gr information, see the section "Gr Diagnostic Viewer of Time-Series Graphs"). The Gr\ and OutlierFinder\ subdirectories must be in the same higher-level directory as Draper, and a directory for each study area should be created in the same higher-level directory, unless a batch file is created at the user's discretion, to launch the program from a different directory.

Execution

Three executable files are included in the Draper Suite distribution: Draper.exe, DraperManager.bat, and DraperManager_debug.bat. Users can run the Draper climate-distribution application by either double-clicking any one of the three startup scripts or executing the commands from a command prompt (appendix 4) within the installation directory. Alternately, command-line options may be placed in a batch file and launched from a file browser window. If options are not specified in the batch file, the Draper executable (Draper) will run in the interactive mode. Draper opens a command-line window (Cmd window; launched using cmd.exe) in the interactive mode. The user is prompted to enter values, and the responses may be in upper or lower case. The options are written to the screen. The executable pauses for the user to press a key before it begins calculating results and writing to the climate-data output file.

Implementation

Draper estimates the spatial distribution of a study area's climate for three data types: (1) daily precipitation (PPT), (2) daily maximum temperature (TMAX), and (3) daily minimum temperature (TMIN). Draper operates on each data type individually without considering input from the other data types, and to generate the climate distribution for all three data types, Draper must be run separately on each data type.

Methods of Operation

If three or more station observations are available for a given day, Draper uses its primary distribution method, which involves running a regression to fit a plane to the station observations that will minimize the sum of errors (residuals) at the points and using the plane to shear the PRISM surface, in effect, tilting it to follow the observed spatial trend of that day. The result incorporates the mean spatial features captured by the PRISM surface as well as the general daily trend indicated by station values.

If only one or two observed values are available on a given day, Draper uses a second method, which averages the available data to scale the PRISM surface. If no observations are available, Draper reverts to a third method, which simply uses the PRISM surface mean-monthly value without modification.

Draper uses a set of required and optional input files that include station observations and locations, gridded-surface (PRISM) values, and model-mapping unit centroid locations. Draper creates a set of output files that include the climate distribution, diagnostic information, and a run log; the files use defined formats and naming conventions.

Draper reads input information in the form of centroid locations of the model-mapping units, the daily climate measurements at station locations, upper and lower bounds of expected climate-data values, and 30-year mean-monthly climate surfaces that are area-weighted for each model-mapping unit (appendix 5). Estimates are made on a daily time step from daily input and for a specified period of record. PRISM surfaces (Daly and others, 1994) are used for the Merced River Basin PRMS case study in this report to obtain the starting values of the distribution calculations, but any climate surface may be substituted if the data units are the same as in PRISM (degrees Fahrenheit [°F] for temperature and inches [in.] for precipitation).

Draper distributes climate data using one of three methods, which are referred to as Methods I, II, and III, each of which is described in more detail below. Method I is the preferred method but is only used on days when three or more stations' values are available. Method II is less sophisticated than Method I but can be used on days when one or two station values are available. Method III is the least sophisticated method and is employed only on days when no station data are available.

A normalization period is required for Draper Methods I and II (appendix 6). For each day, climate measurements of reporting stations are first converted to percentage departures from the long-term daily normal of the corresponding climate station and month of year. If the normalization period is not specified, it is set to the period of record of the input data, which captures historical climate variations. Otherwise, it is set to the specified timeframe, which locks the normalization period to a fixed climatic window, such as from 1980 to 2010.

Draper uses mean-monthly PRISM surfaces as the basis for estimating distributed values. The PRISM-surface climate-data values are represented as either averages or centroids (operator's discretion) of the model-mapping unit areas. PRISM surfaces are preprocessed using GIS (outside of Draper) and written to a formatted file to be read later by Draper (appendix 5, example file, MERCED_PPT_AVERAGES).

Draper Method I

For the mathematical theory of the distribution of precipitation using Draper Method I, see appendix 6. For a given day, if three or more climate measurements are available, a regression plane is made from climate stations reporting on that day, their historical measurement(s), and the latitude and longitude of the station locations. Figure 3 shows a precipitation example with figure 3*A* showing a regression plane of observed daily precipitation as a percent of normal at each observation site. This resulting "percent of normal" plane is used to mathematically shear the 30-year mean-monthly PRISM surface in figure 3*B*, which represents "normal" climate rates for the month. This creates a tilted PRISM surface for each day simulated, resulting in the "draped" appearance in figure 3*C*.

Draper Method II

On days with only one or two climate observations, the PRISM surface is not tilted because three points are required to define a plane. Instead, average precipitation or maximum and minimum temperatures are computed by uniformly scaling the monthly PRISM surface up or down, according to the average "percent-of-normal" for that day's observations. This method also is referred to as the "averaging method." Hydrologic response unit precipitation or temperatures are then estimated by sampling that scaled surface at HRU centroids (fig. 4).

Draper Method III

For days with no measured data, the HRU precipitation or temperature is assumed to be the same as 30-year mean-monthly PRISM surface. The daily PRISM climate-data value is the measurement obtained at the HRU centroid from the PRISM surface that was written to a PRMS formatted file during preprocessing, after necessary unit conversions from inches per month to inches per day (fig. 5).

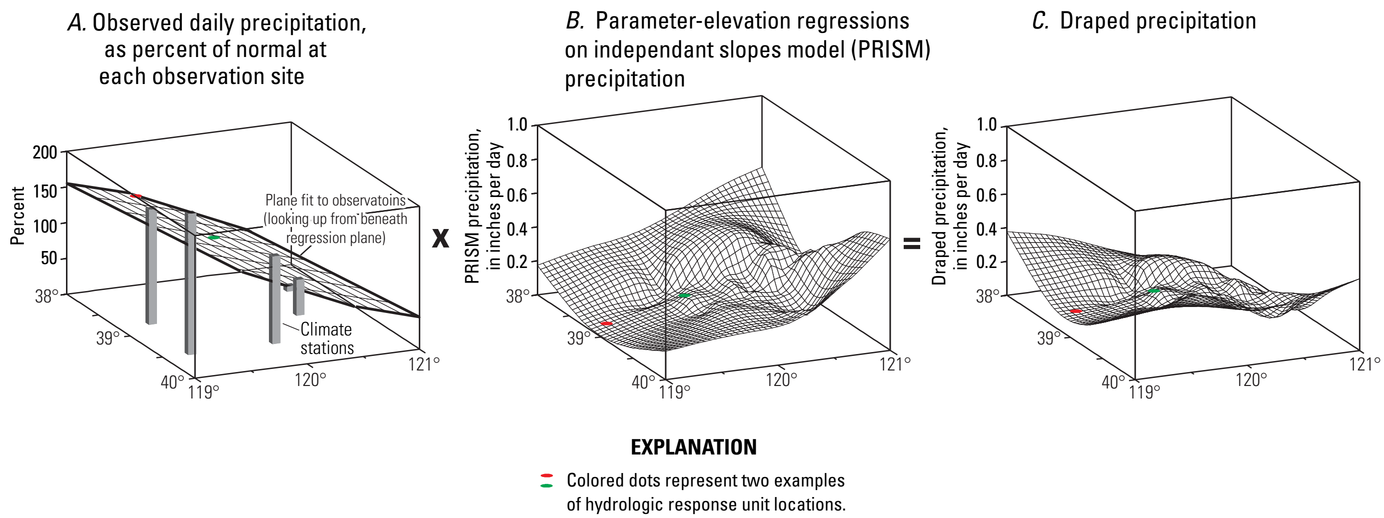


Figure 3. When three or more station measurements are available, Draper Method I is used to estimate daily climate data from Parameter-elevation Regressions on Independent Slopes Model (PRISM) surfaces. This precipitation example uses *A*, a regression plane of observed daily precipitation as a percent of normal at each observation site, and *B*, a 30-year mean-monthly PRISM surface representing "normal" precipitation for the month, to create *C*, a mathematically sheared PRISM surface, appearing as "draped" precipitation. The "X" represents multiplication of the surfaces and the "=" shows the resulting surface.

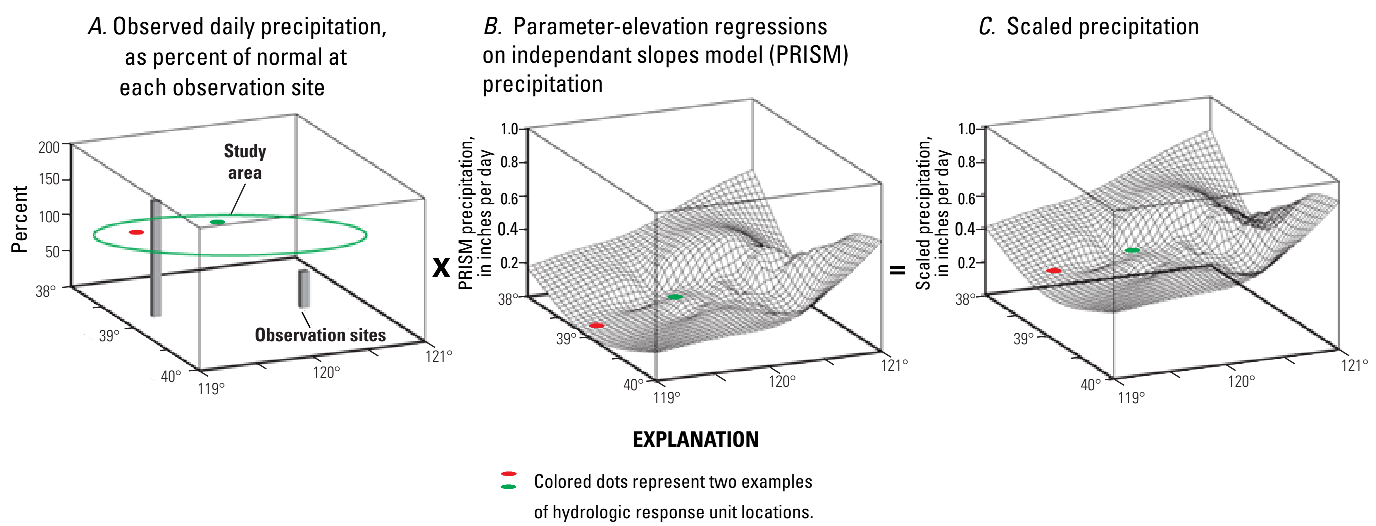


Figure 4. When one to two stations are available, Draper Method II is used to estimate daily climate data from Parameter-elevation Regressions on Independent Slopes Model (PRISM) surfaces, including examples *A*, observed daily precipitation as a percent of normal at each observation site, *B*, mean-monthly PRISM precipitation surface, and *C*, resulting "scaled" precipitation estimates. The "X" represents multiplication of the surfaces and the "=" shows the resulting surface.

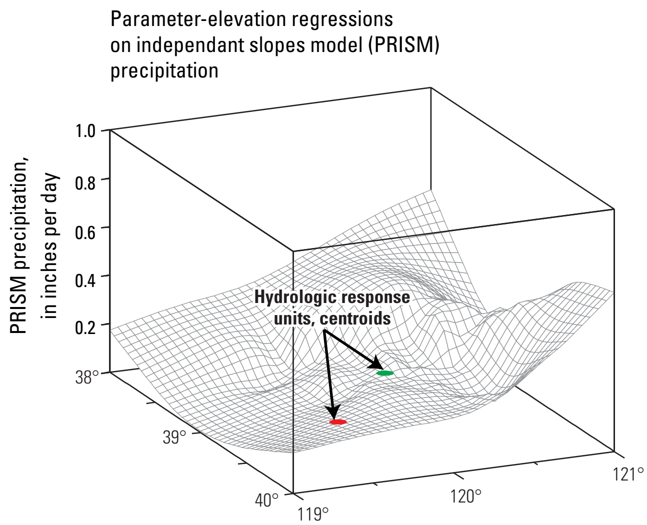


Figure 5. When zero station measurements are available, Draper Method III uses the hydrologic response unit (HRU) summary value of the mean-monthly Parameter-elevation Regressions on Independent Slopes Model (PRISM) at the modeling HRU centroid to represent the missing climate-data value for a day in that month.

Input Files

To compute and distribute precipitation and temperature to model-mapping units (HRUs), Draper looks for several required and optional input files within the directory for the study area, such as MERCED for the Merced River Basin study area (table 1; appendix 5). Each file can be identified in table 1 by a short, uppercase data type that begins the unique part of the file name (following “MERCED”) and thereafter is the file type (there are five exceptions to this naming convention in table 1). Input files are developed outside the Draper Suite and must be formatted as shown in appendix 5. Files used by Draper to make the climate-data output files are listed in table 1. For instructions on making the standard deviation files, see appendix 1.

The study-area directory contains two files that are shared by all data types: (1) the CENTROIDS file, which is required and contains model-mapping unit (HRU) centroid coordinates and (2) the NORM_POR file, which is optional and contains the beginning and ending dates of a normalization period. If the NORM_POR file is not included, Draper will default to using the first and last date found in the climate-station time-series measured data as the normalization period.

Three directories containing data and configuration files for each data type are required within the study-area directory. There are directories named for the PPT (precipitation) data type, the TMAX (maximum daily temperature) data type, and the TMIN (minimum daily temperature) data type.

The remaining input files are within the directory for each data type. The TMAX and TMIN data types have additional required and optional file types that are not presently used for the PPT data type. Because Draper operates on each data type separately, an optional file may be present in one data-type directory, but not in the others.

As can be seen in table 1, the directory for each *data type* contains several different *file types*. A file type is in a specified format and uses a specified naming convention.

The MEAS file, which is required, is a time-series file which contains daily observations of measured or synthesized climate data at the station in inches for precipitation or °F for temperature. Draper expects exactly one input row per day and writes calculated output for each day read. It uses the month of each input row to determine which monthly PRISM value to use in calculations. A value of “–99” is used to denote missing data values in the MEAS file, as opposed to “0.” Zero is presumed to be a real measurement, and Draper will consider the station to be “active” for days that report a value of zero.

A required AVERAGES file contains HRU area-weighted 30-year mean-monthly PRISM values, in inches for precipitation or °F for temperature. The LOCATIONS file is required and contains station-location coordinates.

In the directories for the TMAX or TMIN data types, Draper requires a PRISM_SIGMA file that contains the mean-monthly standard deviations at HRU locations, computed from 30 years of daily PRISM surfaces, in °F. The daily PRISM data that are used are a different product from the monthly PRISM values that are used elsewhere in Draper Suite.

The RANGE file is optional and contains annual or monthly ranges (upper and lower bounds) of expected values of the climate variable for each station. If the RANGE file is not found, Draper will use a default allowable range of 0–35 in. for monthly precipitation and –97 to 150 °F for temperature. Input values outside the range will cause Draper to exit with an error, whereas output values outside of the range will cause Draper to write a warning message.

An optional STA_AVERAGES file, which may be found within each of the data-type directories, contains 30-year mean-monthly PRISM values, in in. for precipitation or °F for temperature, at the station locations. The STA_PRISM_SIGMA file is optional for the TMAX and TMIN data types. It contains the mean-monthly standard deviations at station locations, computed from 30 years of daily PRISM surfaces, in °F. Draper successfully runs without these optional files; however, if they are present, Draper will use them to generate the STA_DIFFS report. For PPT, only the STA_AVERAGES file is needed to allow the report generation. For TMAX and TMIN, both STA_AVERAGES and STA_PRISM_SIGMA files are needed to generate the report.

Table 1. Input files used by Draper are in a MERCED directory for the Merced River Basin study area, California.

[HRU, hydrologic response unit; PPT, daily precipitation; PRISM, Parameter-elevation Regressions on Independent Slopes Model; Shared, used by all three data types; TMAX, daily maximum temperature; TMIN, daily minimum temperature]

File	Size (kilobytes)	Data type	File type	Required	Description
MERCED_CENTROIDS	17,033	Shared	CENTROIDS	Yes	Latitude and longitude at HRU centroids
MERCED_NORM_POR[1]	88	Shared	NORM_POR	No	Normalization period start and end date
MERCED_MEAS_PPT.data	1,671,744	PPT	MEAS	Yes	Daily measured precipitation in inches at each station
MERCED_PPT_AVERAGES	43,055	PPT	AVERAGES	Yes	PRISM mean monthly precipitation at each HRU
MERCED_PPT_LOCATIONS	746	PPT	LOCATIONS	Yes	Latitude and longitude at climate-station location
MERCED_PPT_RANGE[2]	86	PPT	RANGE	No	Annual or monthly data range for input errors or output warnings
MERCED_PPT_STA_AVERAGES[3]	1,787	PPT	STA_AVERAGES	No	PRISM mean monthly precipitation at each station
MERCED_MEAS_TMAX.data	2,212,171	TMAX	MEAS	Yes	Daily maximum temperatures for each station
MERCED_TMAX_AVERAGES	69,965	TMAX	AVERAGES	Yes	PRISM mean monthly maximum temperature at each HRU
MERCED_TMAX_LOCATIONS	902	TMAX	LOCATIONS	Yes	Latitude and longitude at climate-station location
MERCED_TMAX_PRISM_SIGMA	59,392	TMAX	PRISM_SIGMA	Yes	Mean monthly standard deviation of daily PRISM values at each HRU
MERCED_TMAX_RANGE[2]	110	TMAX	RANGE	No	Annual or monthly data range for input errors or output warnings
MERCED_TMAX_STA_AVERAGES[3]	2,324	TMAX	STA_AVERAGES	No	PRISM mean monthly maximum temperature at each station
MERCED_TMAX_STA_PRISM_SIGMA[3]	1,882	TMAX	STA_PRISM_SIGMA	No	Mean monthly standard deviation of daily PRISM values at each station
MERCED_MEAS_TMIN.data	2,209,495	TMIN	MEAS	Yes	Daily minimum temperatures for each station
MERCED_TMIN_AVERAGES	69,965	TMIN	AVERAGES	Yes	PRISM mean monthly minimum temperature at each HRU
MERCED_TMIN_LOCATIONS	902	TMIN	LOCATIONS	Yes	Latitude and longitude at climate-station location
MERCED_TMIN_PRISM_SIGMA	59,392	TMIN	PRISM_SIGMA	Yes	Mean monthly standard deviation of daily PRISM values at each HRU
MERCED_TMIN_RANGE[2]	110	TMIN	RANGE	No	Annual or monthly data range for input errors or output warnings
MERCED_TMIN_STA_AVERAGES[3]	2,332	TMIN	STA_AVERAGES	No	PRISM mean monthly minimum temperature at each station
MERCED_TMIN_STA_PRISM_SIGMA[3]	1,882	TMIN	STA_PRISM_SIGMA	No	Mean monthly standard deviation of daily PRISM values at each station

[1]If not included, Draper will default to using the first and last date found in the climate-station time-series measured data.

[2]If not included, Draper will use a default range of 0 to 35 inches for precipitation and –97 to 150 degrees Fahrenheit for temperature.

[3]If not included, Draper will not compute the STA_DIFFS report.

Running Draper

Draper is run using the draper.exe file. Figure 6 shows options entered to generate a climate-data output file of daily precipitation. For an example of the directory architecture of Draper for the Merced River Basin PRMS example, see appendix 2. The Draper executable revision date is printed to screen (fig. 6, line 1). The study-area name entered (fig. 6, line 4) denotes the name of the workspace directory and where model-mapping unit centroid and normalization-period files are stored, as well as the naming convention of each input file. The subfolder (fig. 6, line 6) specifies the data type, where input files are stored, the method of computations employed based on the type of data processed (appendix 6; PPT, TMAX or TMIN), and the directory where climate-data output files are written. The preset normalization period and ranges of expected values are read from files MERCED_NORM_POR and MERCED_PPT_RANGES and written to the console (fig. 6, lines 9–11).

In this example, the climate-data output file called MERCED_DRAPER_PPT.data is written to directory MERCED\PPT\. The method of computations and other conditions are printed to screen (fig. 6, line 12). The final PRMS formatted file is always named in the form of “study area”_DRAPER_”datatype” data. In this example, the climate-data output file is named “MERCED_DRAPER_PPT.data.” Press Enter to begin interpolation and make the climate-data output file. Older output files are overwritten with each new run.

DraperManager

DraperManager acts as a shell that calls draper.exe. The program’s console text output is identical to that written from Draper (as launched from the command line), except for lines starting with “DraperManager>>>,” which are messages from DraperManager. DraperManager expands the functionality of Draper by providing options to append new results to the preexisting output or generate a statistical comparison between old and new results.

The workflow for an example operational application of DraperManager is shown in figure 7. Each run of the program uses a new read-in of the input. The new input could be identical (pointless replication) or could simply have additional data appended to the end, but it also could contain changes to previous datasets. For each run, DraperManager passes the input to Draper to create a climate distribution. DraperManager then merges that distribution with the previous distribution, with all previous values remaining intact and any new values appended to the end. It then performs a comparison between the old and new distribution and reports the differences.

DraperManager is run by launching the DraperManager.bat file. Alternately, DraperManager_debug.bat can be executed; it runs DraperManager with the option to write additional debug information.

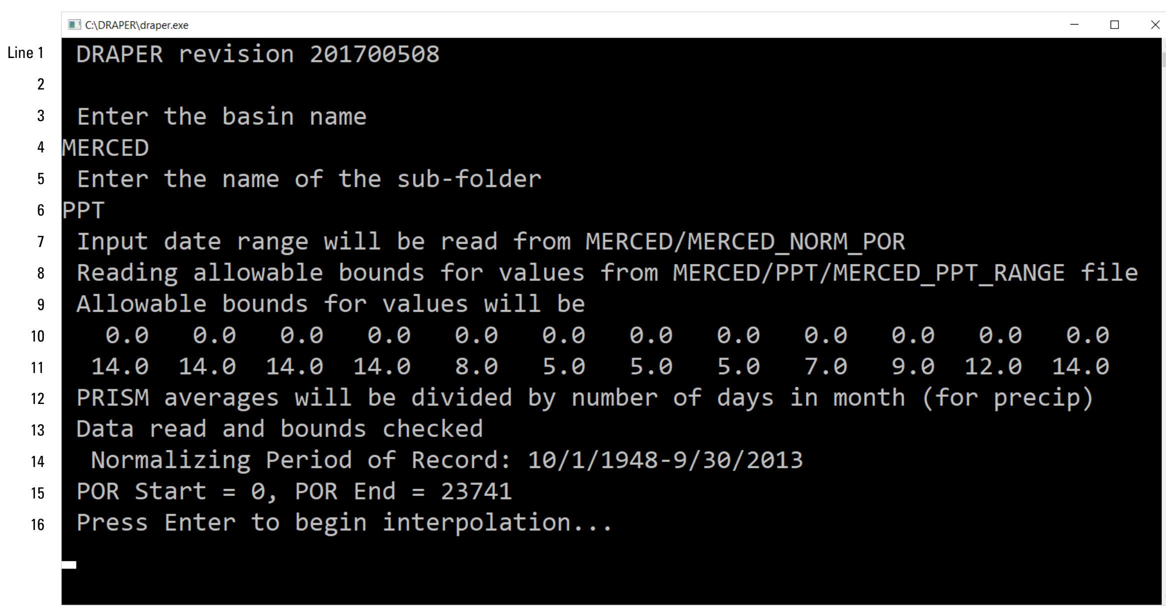


Figure 6. Draper command window showing Draper revision date (line 1), user’s entries for study-area name (line 4) and data-type selection (line 6); program reported upper and lower allowable bounds (lines 10, 11), climate-data computation format (line 12), and normalization period (line 14).

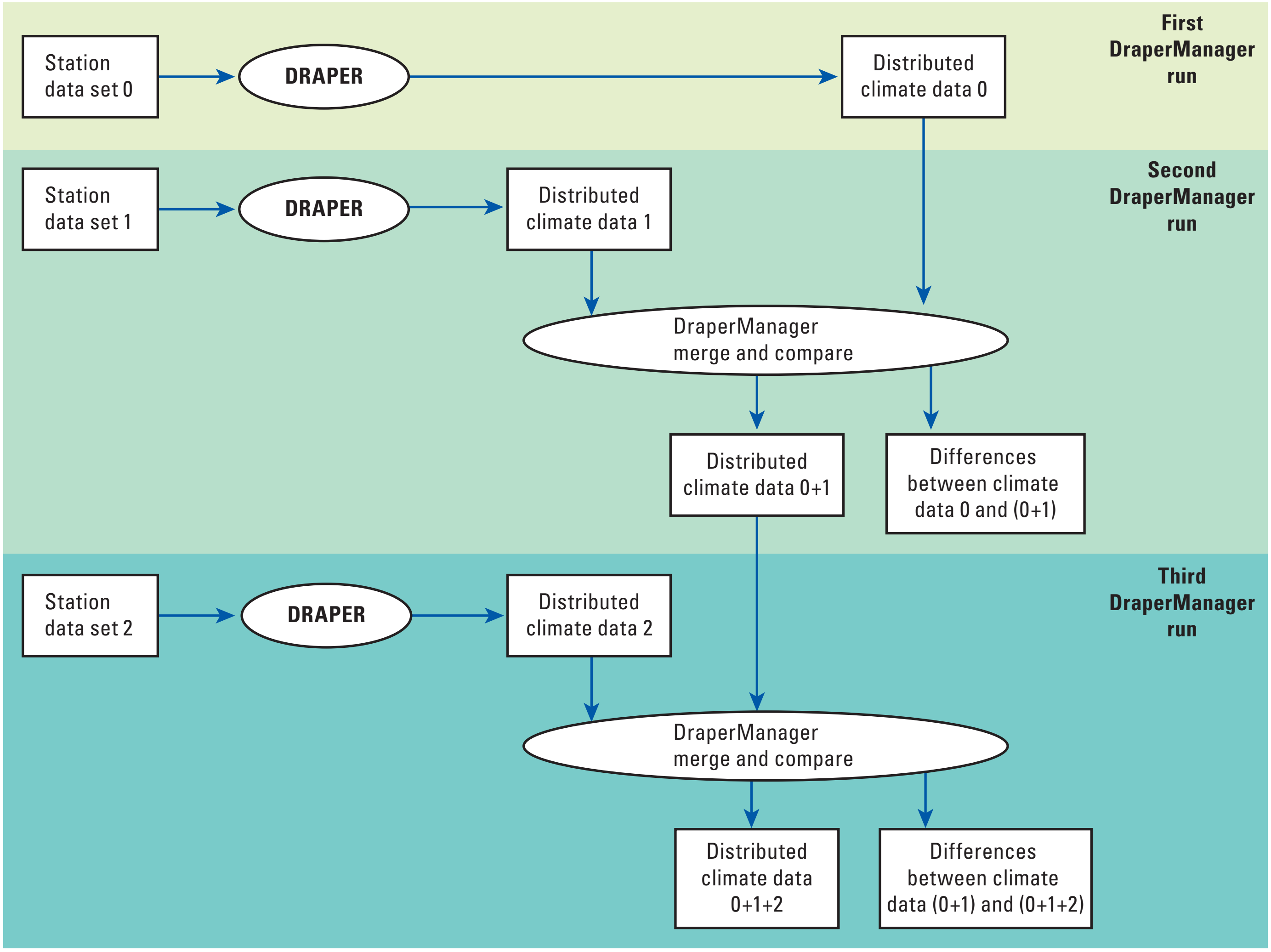


Figure 7. Three runs of DraperManager using Station Datasets 0, 1, and 2. Each successive dataset could include changes and appended data. In each run, observed station daily data are passed as input to Draper, which estimates spatially continuous distribution of daily climate data. DraperManager then merges the distributed climate data with those from previous runs to create a new output dataset and compares it to the previous version.

The DraperManager command window is shown in figure 8. The DraperManager revision date is printed to the screen (fig. 8, line 1). The first two values entered by the user are the same as for Draper. In this example, the option to append new data to the previous climate-data output file (fig. 8, line 15) is set as "y" = yes. Otherwise, if set to "n" = no, then the previous climate-data output file will be overwritten. The option to perform a statistical comparison with a previous climate-data output file (fig. 8, line 18) is set to "y" = yes. Otherwise, if set to "n" = no, then no statistical comparison will be performed. Presets for the normalization period and ranges of expected values are printed to the screen (fig. 8, lines 20, 23, 24). The computations method is printed to screen (fig. 8, line 25), based on the type of data specified (line 12). In this case, the old climate-data output file is saved and renamed to MERCED_DRAPER_PPT_001.data.

If the "summary statistics" option (fig. 8, line 18) is set to "y," the program prints the differences between previous and new climate-data output files for each day of record for each HRU to the screen as well as to a text file with the same name as the climate-data output file but with a ".diff" extension. This option is useful for comparing runs using different normalization periods or for comparing revised historical data (see section "Evaluating and Improving Results"). If the option to generate the statistical comparison is set to "y," summary statistics will print to screen and, in this example, to the file "MERCED_DRAPER_PPT_001.diff."

Figure 9 (lines 2, 3) reports to the screen that some of the initial Draper climate-data output estimates were outside the preset (or user-defined) range and Draper reverted to Draper Method II (the averaging method). Notes are printed to the screen and, in this example, to the log file MERCED_PPT_DRAPER_LOG.

```
Line1 Draper Manager revision 20170508
2  U.S. Geological Survey, 2014-2017
3  USGS California Water Science Center
4
5  >>Draper Manager: Running DRAPER...
6
7   DRAPER revision 201700508
8
9   Enter the basin name
10 MERCED
11  Enter the name of the sub-folder
12 PPT
13
14 Append new values to previous output (vs. overwriting all)? (y/n)
15 Y
16
17 Generate statistical comparison with previous run? (y/n)
18 Y
19 >>Draper Manager: temporarily moving existing output to _000.data
20 MERCED/MERCED_NORM_POR not found, so period of record will be entire input range
21  Reading allowable bounds for values from MERCED/PPT/MERCED_PPT_RANGE file
22  Allowable bounds for values will be
23    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
24   14.0  14.0  14.0  14.0   8.0   5.0   5.0   5.0   7.0   9.0  12.0  14.0
25  PRISM averages will be divided by number of days in month (for precip)
26  Data read and bounds checked
27   Normalizing Period of Record: 9/30/1913-9/30/2013
28  POR Start = 0, POR End = 23741
29  Press Enter to begin interpolation...
```

Figure 8. DraperManager command window showing DraperManager revision date (line 1), message that DraperManager is running Draper (line 5), Draper revision date (line 7), user's entries for study-area name (line 10), data-type selection (line 12), option to append new data records to a previous climate-data output file (line 15), option to perform statistical comparison between data in new and previously run climate-data output files (line 18), upper and lower result bounds (lines 23, 24), climate-data computation format (line 25), and normalization period (line 27).

```
Line 1 Interpolated data through 01/01/2003
2   WARNING: Switching to averaging method because regression plane produced out of
3     range value (      5.1) on 07/31/2003
4  Interpolated data through 01/01/2004
5  Interpolated data through 01/01/2005
6  Interpolated data through 01/01/2006
7  Interpolated data through 01/01/2007
8  Interpolated data through 01/01/2008
9  Interpolated data through 01/01/2009
10 Interpolated data through 01/01/2010
11 Interpolated data through 01/01/2011
12 Interpolated data through 01/01/2012
13 Interpolated data through 01/01/2013
14
15
16 >>Draper Manager: DRAPER finished
17 >>Draper Manager: Moving new output to _001.data
18 >>Draper Manager: Merging new and old output
19
20 >>Draper Manager: Generating diff file and statistics...
21
22 Number of values that differed = 0 of 15621578
23 Mean of absolute values of differences = NaN
24 Maximum difference = 0.0 at , column 0
25 >>Draper Manager: Output now contains previous output with new values appended
26
27
28 >>Draper Manager: Finished
29
30 Press any key to close...
```

Figure 9. DraperManager command window showing the termination of a Draper run, revealing that Draper defaulted to the averaging method for the date July 31, 2003, (lines 2, 3) and showing the file name extension (.data) of the statistical comparison output file (line 17), and summary statistics comparing old and new versions of climate-data output files (MERCED_DRAPER_TMAX.data; lines 18–20).

Output Files and Diagnostic Information

Draper and DraperManager write a total of six different types of output files (table 2; appendix 7). The primary file of interest is the climate-data output file used to drive the physically based environmental model. Draper also prints files used to aid in understanding the quality of the input and output data. Further, DraperManager saves copies of previous runs, appends data to copies of previous climate-data output files, and performs statistical evaluations (table 2).

For the Draper- and DraperManager-generated output file types, each type is described in the following subsections of this report. See also appendix 2 for examples of names and locations of output files for the Merced River Basin PRMS application. See appendix 7 for examples of output file contents.

Draper Output Files and Diagnostic Information

Draper generates four types of output files (table 2; appendix 7). These output files are the climate-data output file, the log file, diagnostic spreadsheet, and differences file.

Climate-Data Output File in Precipitation-Runoff Modeling System Format

Draper generates climate-data output files that are formatted for direct use as PRMS time-series input files. Climate-data output files contain estimates applicable at each HRU centroid for each day of the specified period (appendix 7).

The climate-data output files made from Draper runs in the Merced River Basin example are named MERCED_DRAPER_PPT.data, MERCED_DRAPER_TMAX.data, or MERCED_DRAPER_TMIN.data. These examples of climate-data output files were written to their respective data-type subdirectories in the study-area directory (for example, .\DRAPER\MERCED\PPT\ for the file MERCED_DRAPER_PPT.data).

Table 2. Draper and DraperManager output files from example runs with datasets for Merced River Basin Precipitation-Runoff Modeling System.

[PRMS, precipitation runoff modeling system]

File	Size (kilobytes)	Description
Generated from Draper only		
MERCED_DRAPER_PPT.data	107,369	Climate output, PRMS formatted file
MERCED_DRAPER_TMAX.data	76,812	Climate output, PRMS formatted file
MERCED_DRAPER_TMIN.data	76,812	Climate output, PRMS formatted file
MERCED_PPT_DRAPER_LOG	7	Draper run recorded errors, warnings, and messages
MERCED_TMAX_DRAPER_LOG	22	Draper run recorded errors, warnings, and messages
MERCED_TMIN_DRAPER_LOG	4	Draper run recorded errors, warnings, and messages
MERCED_PPT_STA_DIFFS	43	Diagnostic statistics for station measurements
MERCED_TMAX_STA_DIFFS	42	Diagnostic statistics for station measurements
MERCED_TMIN_STA_DIFFS	42	Diagnostic statistics for station measurements
MERCED_PPT_DRAPER_DIAG.csv	3,594	Diagnostic statistics describing Draper output
MERCED_TMAX_DRAPER_DIAG.csv	3,594	Diagnostic statistics describing Draper output
MERCED_TMIN_DRAPER_DIAG.csv	3,594	Diagnostic statistics describing Draper output
Additional files generated by DraperManager		
MERCED_DRAPER_PPT_001.data	107,369	Previous climate output may be saved and numbered sequentially
MERCED_DRAPER_TMAX_001.data	76,812	Previous climate output may be saved and numbered sequentially
MERCED_DRAPER_TMIN_001.data	76,812	Previous climate output may be saved and numbered sequentially
MERCED_DRAPER_PPT_001.diff	1	Statistical comparisons of current and previous runs
MERCED_DRAPER_TMAX_001.diff	1	Statistical comparisons of current and previous runs
MERCED_DRAPER_TMIN_001.diff	1	Statistical comparisons of current and previous runs

Log File and the Screen Error Messages

The Draper log file contains statements printed when results exceed upper and lower bounds of the expected value limits set in a range file (for example, MERCED_PPT_RANGE; appendixes 3, 7). Error messages are also written to the screen. Statements recording the averaging method used, when Draper Method I (the regression plane method) is applied and when out-of-range values are produced, are written as American Standard Code for Information Interchange (ASCII) text to the following:

.\DRAPER\MERCED\PPT\MERCED_PPT_DRAPER_LOG

.\DRAPER\MERCED\TMAX\MERCED_TMAX_DRAPER_LOG

.\DRAPER\MERCED\TMIN\MERCED_TMIN_DRAPER_LOG

Diagnostic Spreadsheet

Draper writes diagnostic information to a spreadsheet in each data-type subdirectory, in *.csv (comma separated values) format, with a filename ending in "_DIAG.csv" (appendix 2). Records are written in ascending order by date (rows) and diagnostic data type (columns). The diagnostic spreadsheet contains a row of summary statistics describing the daily measured input data and calculations for each day of the Draper run. For an example of this output file, see appendix 7.

Differences File—Differences Between Station Measurements and Draper Estimates at the Station Locations

Draper estimates climate-data values at HRU centroids using PRISM-derived averages at those locations; however, it also can calculate climate-data values at station locations for determining the error between the calculated values and the observed station measurements. The PRISM-derived averages at the station locations must be saved to do this; these supplemental inputs to Draper are provided in files with names ending in "STA_AVERAGES."
Examples of location files (table 1; appendix 2) are below:

.\DRAPER\MERCED\PPT\MERCED_PPT_STA_AVERAGES

.\DRAPER\MERCED\TMAX\MERCED_TMAX_STA_AVERAGES

.\DRAPER\MERCED\TMIN\MERCED_TMIN_STA_AVERAGES

If Draper finds these files, it will first calculate the errors between the estimated station values and the observed station measurements, and then create the following "STA_DIFFS" files that report the magnitude of the errors. The differences between station measurements and calculated values are reported as summaries only, that is, averaged to monthly and annual reporting intervals, as well as for individual stations and all the stations collectively. Days with missing station data are not included in any of the averages. The reported averages do not describe whether the calculations were higher or lower than the observed values, only how much they differed in magnitude.

.\DRAPER\MERCED\PPT\MERCED_PPT_STA_DIFFS

.\DRAPER\MERCED\TMAX\MERCED_TMAX_STA_DIFFS

.\DRAPER\MERCED\TMIN\MERCED_TMIN_STA_DIFFS

The first table in the "STA_DIFFS" file summarizes the average difference for all years. Subsequent tables give the differences for each individual year. In each table, each column contains the average difference by month, with the final column labeled "ALL" and containing the average for all months. The rows contain the average difference by station, with the final row labeled "ALL" and containing the average for all stations. The value at the intersection of the "ALL" column and the "ALL" row is the average for all months at all stations. This value appears in the bottom-right corner of the individual year summary tables as well as the table for all years.

DraperManager Output Files and Diagnostic Information

In addition to the four output files that Draper generates, when DraperManager is running as the outer shell it generates two more sets of output files. One set consists of climate-data output files from previous runs of Draper. The other set is a summary of differences between the newest climate-data output file and the climate-data output from previous runs of Draper for the same study area. Each set of files is next described in more detail.

Stored Previous Runs of Climate-Data Output Files

Previous output is numbered sequentially and written to a file (for example):

.\DRAPER\MERCED\PPT\MERCED_DRAPER_PPT_001.data

.\DRAPER\MERCED\TMAX\MERCED_DRAPER_TMAX_001.data

.\DRAPER\MERCED\TMIN\MERCED_DRAPER_TMIN_001.data

Stored Previous File of Summarized Differences of Measured and Parameter-Elevation Regressions on Independent Slopes Station Averages, and Old and New Climate-Data Output

Statistical comparisons of current and previous Draper runs are written to the screen and a "diff" file when the run is complete (for example, MERCED_DRAPER_PPT_001.diff or MERCED_DRAPER_PPT_00#.diff files thereafter). The diff file records the differences in estimates between the most recent climate-data output file and the previous climate-data output file, with each new instance of the diff file numbered sequentially. The file format is described in appendix 7. The set of these files resulting from successive runs of Draper in DraperManager are written to the same respective data-type subdirectories containing the primary (original) climate-data output files (for example):

.\DRAPER\MERCED\PPT\MERCED_DRAPER_PPT_001.diff

.\DRAPER\MERCED\TMAX\MERCED_DRAPER_TMAX_001.diff

.\DRAPER\MERCED\TMIN\MERCED_DRAPER_TMIN_001.diff

Evaluating and Improving Results

The tools and methods described in this section may be used iteratively as passes are made from data measured at stations to climate-data output distributed to modeling HRUs and tested in the physically based environmental model. For general tips on editing Draper input files to get different desired output results, see appendix 8.

Log File

The Draper log file contains statements printed when results exceed upper and lower bounds of the expected value limits set in a range file (for example, MERCED_PPT_RANGE; appendixes 3, 7). Resulting values may produce out-of-range values, for example, when the resulting regression plane is too steep, and values are extrapolated to the edge of the basin, outside the interpolation plane. In this case, Draper defaults to sampling the initial 30-year mean-monthly PRISM surface, as it also will do if only 0–2 measurements are available for a day. This built-in check is a useful tool for assessing whether bounds are realistic. If too many days are estimated with defaulted conditions, this may indicate the expected precipitation bounds are too narrow or unrealistic for the study area or that station coverage is not sufficient to define a robust regression plane.

Data-Evaluation Tools for Draper Input

The quality of measured climate data may be assured with the help of the tools DraperManager, OutlierFinder, and PrmsDiff.

DraperManager

The purpose of DraperManager is to manage multiple runs of Draper with the option to merge climate-data output files. DraperManager also can compute basic statistics about the differences between the latest climate-data output file and the previous one.

To run DraperManager, invoke DraperManager.bat in a PC file-browser window. This shell runs Draper by calling draper.exe and opens a window for command-line input. Fill in the "study-area name" and "data-type" entry options as you would with Draper (fig. 6). Entered responses are not case sensitive.

When using DraperManager_debug.bat, header information is printed to the climate-data output file, which includes the items in the list below.

1. Mean-daily value for each month at each station during normalizing period.
2. Count of valid measurements for each month at each station during normalizing period.
3. Minimum of input measurements for each station during normalizing period.
4. Maximum of input measurements for each station during normalizing period.
5. Minimum of input measurements for each station during total period.
6. Maximum of input measurements for each station during total period.

This summary is used to gain a quick picture of the measured data at climate stations used in the Draper computations. This information is helpful, for example, when the climate-data output file is used to drive the Merced River Basin PRMS model and the resulting simulations show an unusually high streamflow day, but measured station data do not show it. It could be that on a particular day, one precipitation station erroneously reported high rainfall, which skewed the Draper results. Using DraperManager_debug.bat, the modeler can sometimes quickly identify a reason for the estimated anomaly. An example of the header generated by DraperManager_debug.bat is in appendix 7.

OutlierFinder

OutlierFinder is a more advanced method to identify potentially incorrect data in the Draper time-series climate-data inputs and provides a context for deciding whether to keep certain data as part of the Draper climate-data input. OutlierFinder compares measured data from each station against the expected values or expected day-to-day changes in values.

The expected values of each station are determined by quantifying the relation between each pair of stations. For a given pair of stations in the measured input record, the relation of one to the other is plotted, and a polynomial curve is fitted through the points (fig. 10).

For hypothetical Station A and Station B, the regression might show that on cooler days, Station B averages about 25 degrees warmer than Station A, but on warmer days, Station B averages about 30 degrees warmer than Station A. Using this relation, an expected value at Station B can be determined for each day with an observed value at Station A. Each station is then paired individually with all other stations, and a polynomial curve is fit for each pairing (fig. 11).

Only a subset of the stations reports data on most days in the time series. For a given station on a given day, OutlierFinder uses the fitted curve relation between that station and every other station reporting on that day to determine several expected values, which are then averaged to arrive at a mean expected value. The difference between this value and the actual measured value is plotted in the OutlierFinder graph window (fig. 12, middle graph). For example, if the difference is greater than 4.5 in. for precipitation, or 20 degrees for temperature, the station value is flagged as a possible outlier for that day.

OutlierFinder also calculates the day-to-day change for the stations. If the change on a certain day at one station is significantly higher or lower than the mean change at the other stations, that value is flagged as a possible outlier for that day. The difference between the day-to-day change and the expected change for each station is plotted in the OutlierFinder graph window (fig. 12, top graph).

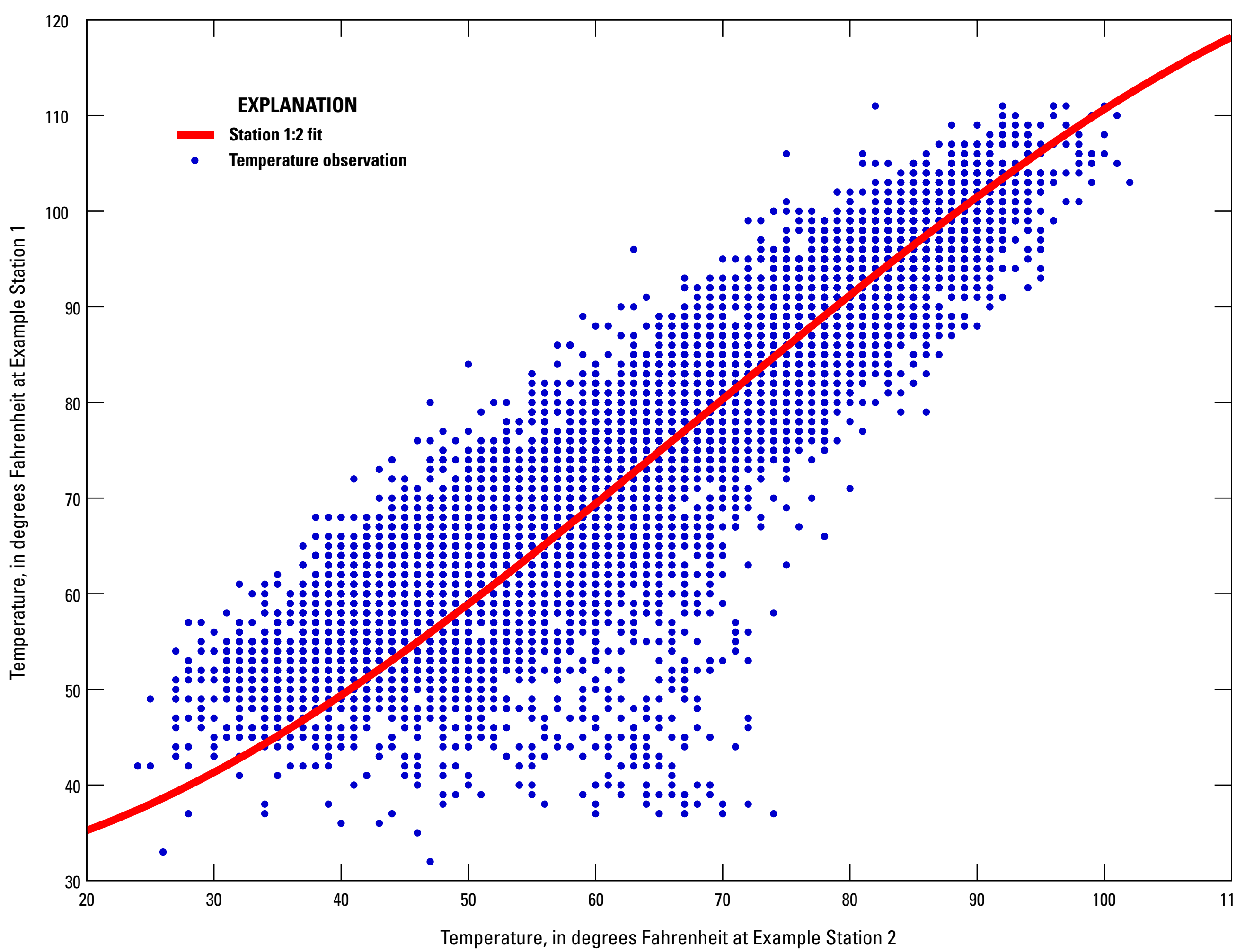


Figure 10. Relation of observed temperatures at one station to observed temperatures at a different station. OutlierFinder fits a polynomial regression curve through the points.

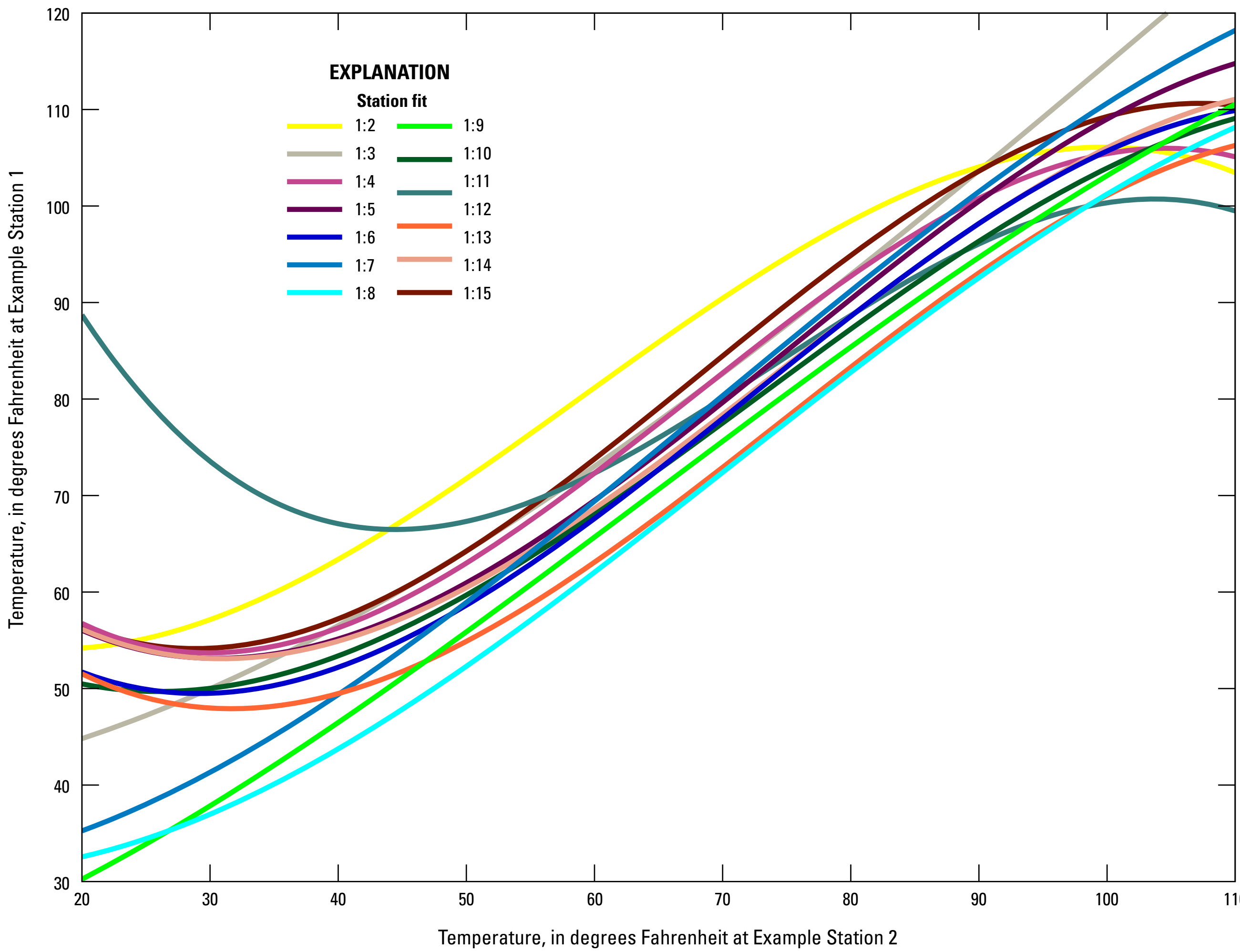
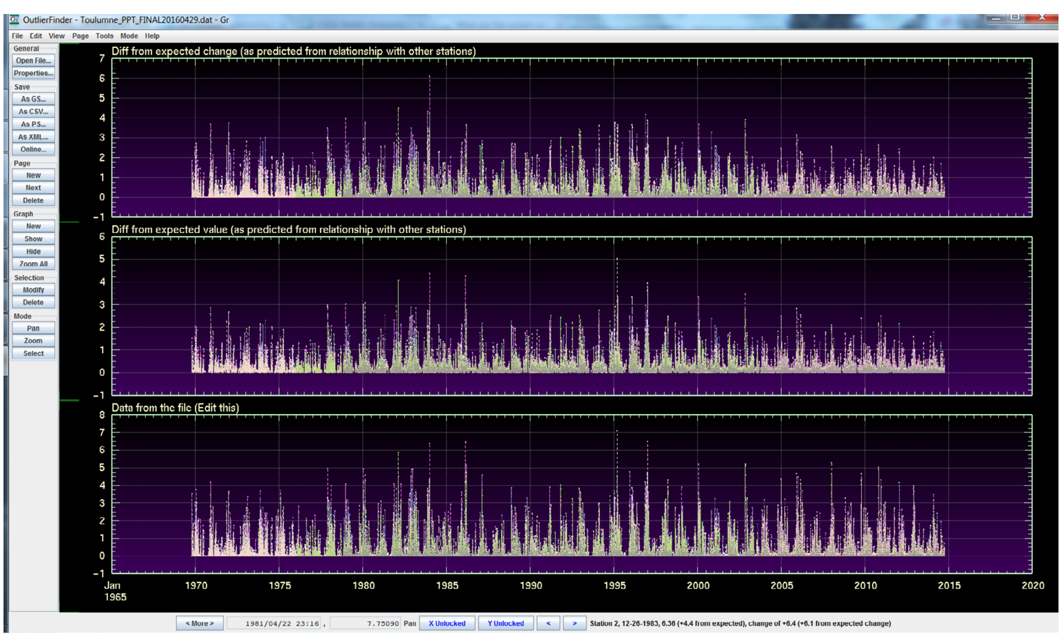


Figure 11. OutlierFinder curves fit for one temperature station to many other temperature stations to arrive at individual curves that describe the relation between each pair of stations.



Note: Data shown are for the purpose of example and should not be used or interpreted for any other purpose.

Figure 12. OutlierFinder graph window containing three graphs for precipitation.

In addition to flagging as possible outliers the daily value differences and day-to-day change differences, OutlierFinder also flags each instance of a station reporting the same value for five or more consecutive days, which can potentially indicate an equipment problem with the data collection. OutlierFinder does not analyze the relation between stations when flagging this type of incident, so the user may want to view the graph of other stations during the same period to determine whether the station was following the trend at the other stations or was truly an outlier by having several consecutive day-to-day changes of zero.

OutlierFinder only compares measured climate data at stations. Files must be formatted as PRMS data files. OutlierFinder does not operate on or identify outliers in other types of datasets used in the Draper workflow.

Running OutlierFinder

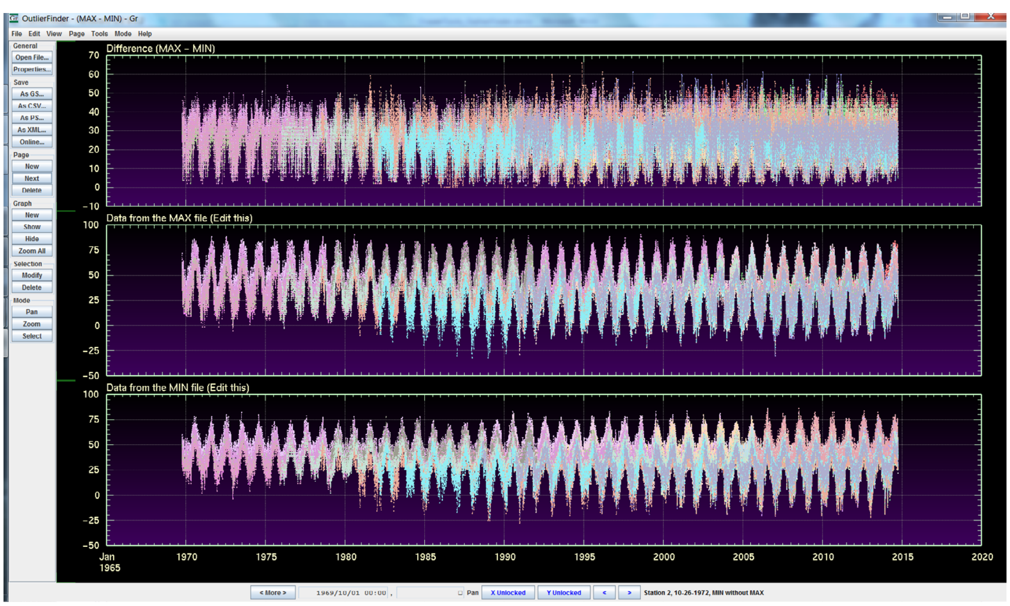
To run OutlierFinder, copy the time-series measured climate-data files to the OutlierFinder directory. In the Merced River Basin PRMS example, these files are called MERCED_MEAS_PPT.data, MERCED_MEAS_TMAX.data, and MERCED_MEAS_TMIN.data (appendix 2). For precipitation data, drag the measured climate data onto OutlierFinder.bat. This opens a console window with messages along with a graph window. For temperature data, make sure the TMAX file has “max” and the TMIN file has “min” somewhere in the name (either lowercase or uppercase) so they can be identified. Select the TMIN and the TMAX files simultaneously by clicking one and then holding the Ctrl key while clicking the other. Drag the two selected files onto OutlierFinder.bat and wait for the console and graph windows to open. The list of possible outliers will be written to a file named “of.txt,” overwriting any previous versions of that file.

Layout

The graph window for precipitation data contains three graphs that share a common date axis (fig. 12). The bottom graph of figure 12 contains all the time series from each station as read from the measured data file. Each of the stations’ time-series climate data are drawn in a unique color. The middle graph contains a time series for each station of the difference between the actual value and the expected value. The top graph contains a time series for each station of the difference between the actual and expected day-to-day change. When TMIN and TMAX files of measured data at stations are opened together, each is shown on its own “page” in OutlierFinder. A third page also is shown (fig. 13), which contains data from the TMIN file in the lower graph, data from the TMAX file in the middle graph, and the difference (TMAX–TMIN) in the top graph. To view a different page, click the Next button under the Page section of the toolbar on the left side of the window.

Stepping Through

To identify individual outliers, first zoom in on a period of a few months to see more detail. To do this, hover the mouse over the X-axis of one of the graphs until a vertical line appears (fig. 14). Click and drag the mouse left or right until a period of several months is selected, then release the mouse. This can be repeated to zoom in further.



Note: Data shown are for the purpose of example and should not be used or interpreted for any other purpose.

Figure 13. OutlierFinder graph window showing the third page of graphs for minimum daily temperature (TMIN) and maximum daily temperature (TMAX) data. Data from the TMIN file are plotted in the lower graph, data from the TMAX file are plotted in the middle graph, and the differences (TMAX–TMIN) are in the top graph.

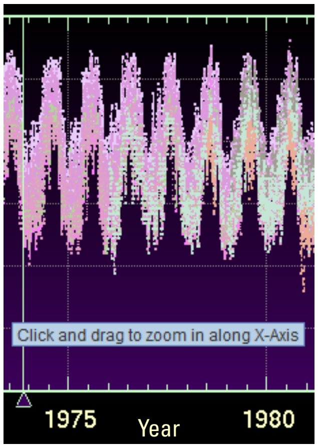
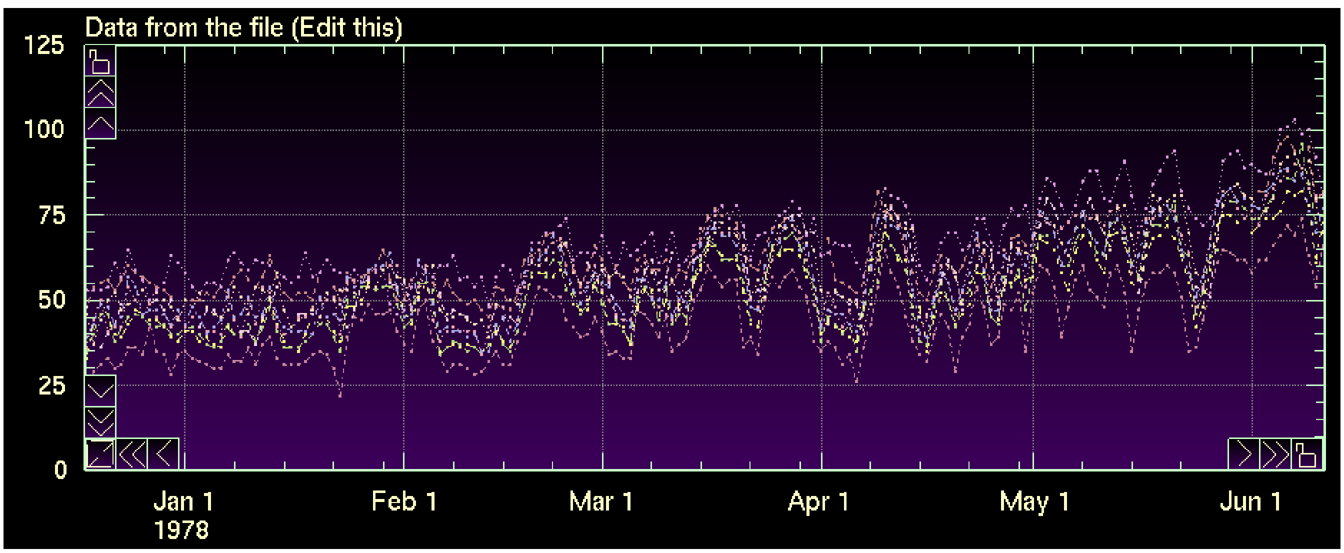


Figure 14. OutlierFinder graph window showing the pointer symbol, vertical marker line, and tooltip that appear when the mouse is hovered over the date axis.

Once the graph has been zoomed in, click and drag the mouse in the graph area to pan side to side to see more data. Alternately, hold down the Ctrl key and tap the left arrow or right arrow on the keyboard to pan left or right.

When the mouse is hovered over the X-axis, several buttons appear in the corner of the axis, as shown in figure 15. The button in the lower left corner is Zoom All, which causes the graph to zoom out to display all data. The middle button zooms out completely on the left side, and the button to its right zooms out only part way on the left side. The same buttons are available along the other side of the X-axis for zooming out to the right. A corresponding set of buttons is available along the Y-axis for zooming out vertically. Figure 15 also shows the Lock button, which toggles locking the axis in place while the other axis is freely movable.



Note: Data shown are for the purpose of example and should not be used or interpreted for any other purpose.

Figure 15. OutlierFinder graph window showing the buttons for zooming out that appear when the mouse is hovered over the left or bottom axis.

Two buttons at the bottom of the graph can be used to pan to the next or previous outlier in the list, as shown in figure 16. A description of the current outlier is written next to the buttons, including the value of the outlier. Each time one of the buttons is clicked, the X-axis is panned so that the outlier is centered in the graph.

Recognizing Outliers

Various methods are used for identifying outliers. For example, outliers can be identified by looking for spikes in either one or both of the top two graphs, indicating a large difference from the expected value or expected daily change, as shown in figure 17.

To determine whether an outlier should be removed, the difference from the predicted value should be considered first. For example, a temperature difference of more than 30 degrees may stand out as a potential problem. A determination should not be made, however, until the trend with all other stations also is considered. If all the other stations are trending colder during a period of several days but one station is lagging by a day, it will show a spike on the different graphs, even though the difference can be explained by the time lag. For temperature data, it also is helpful to check the (TMAX–TMIN) graph to compare the trend in daily range between the daily maximum and minimum temperatures.

The user also may need to determine whether the same value appearing many days in a row is acceptable. A helpful strategy is to compare the data to data at other stations during the same days to observe if they are varying or if they also are staying about the same.

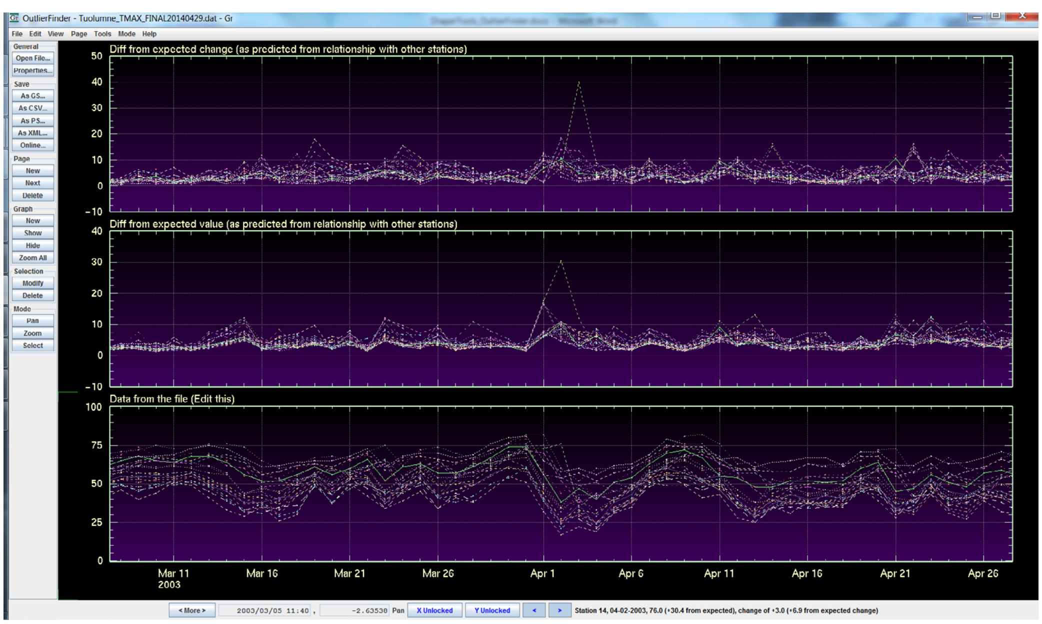
Other considerations are seasonal relations between stations. For example, stations in lowlands, such as California's Central Valley, are usually warmer than stations high in the mountains, but this relation can occasionally be inverted in the winter if valley fog is present while the mountains are sunny.

Editing and Saving Changes

To remove a data value, first select the outlier by clicking the Select button in the Mode section of the toolbar, then click and drag a selection box around the point. To delete the outlier, either click the Delete button in the Selection section of the toolbar or press the Delete key on the keyboard.

To save changes, open the Properties Dialog box by clicking the Properties button in the General section on the toolbar. As shown in figure 18, select the PrismDataFile node in the tree that needs to be saved, and note the file name listed in the table. To save the file, right-click the PrismDataFile node in the tree and select Save or Save As from the menu that appears.

Figure 16. OutlierFinder graph buttons used to pan to the next (>) or previous (<) outlier as well as display the data value and description of the current outlier.



Note: Data shown are for the purpose of example and should not be used or interpreted for any other purpose.

Figure 17. OutlierFinder graph window showing a possible outlier as a spike in the top graph and the middle graph. The corresponding value from the data file is the high value directly below the spikes, in the bottom graph.

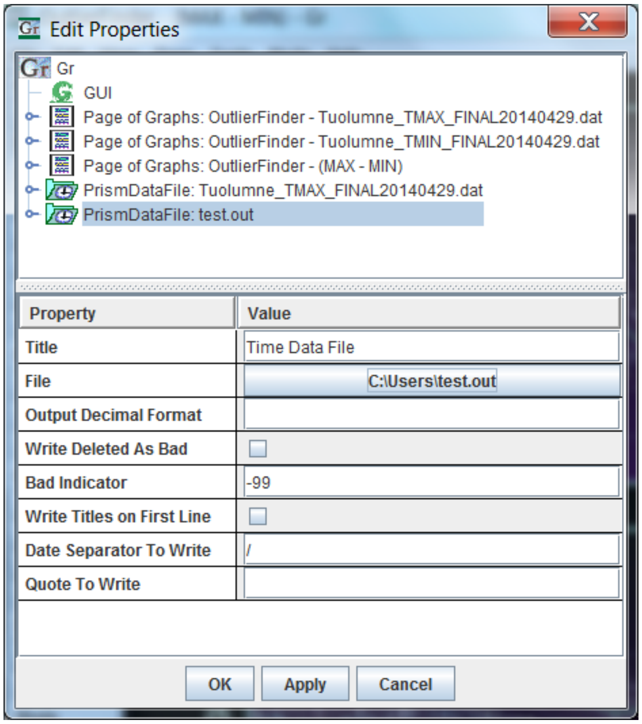


Figure 18. OutlierFinder Properties Dialog window with the "PrismDataFile: test.out" node selected in the top area. The property names and values for the selected node are displayed in the table shown in the bottom area, including the "File" property on the second row, which shows the file's full pathname as "C:\users\test.out."

Output—Outlier List

The outlier list is a list of days, station by station, where the station's measured data value is flagged as a possible outlier. The entries in the outlier list are of two formats. The first format is structured as defined by the following:

```
Station STA_NUM, MM-DD-YYYY, DATA_VALUE
(VALUE_DIFF from expected), change of
DAILY_CHANGE (CHANGE_DIFF from expected
change)
```

In this entry type, STA_NUM is the station number, MM-DD-YYYY is the date, and DATA_VALUE is the station's measured data value as read from the file. The difference between the measured data value and the expected value is VALUE_DIFF, which is calculated from the other station values. The entry VALUE_DIFF includes a sign, with positive indicating the measured value was larger than expected. DAILY_CHANGE is the change from the previous day's value, and CHANGE_DIFF is the difference between the measured change and the expected value, calculated from the mean change of the other stations from the previous day.

The following example shows that station 4 on March 7, 1998, had a temperature value of 57.0 degrees, which was 12.8 degrees higher than expected, based on the other station values. The change from the previous day was an increase of 26 degrees, which was 22.9 degrees greater than the mean change of the other stations.

```
Station 4, 03-07-1998, 57.0 (+12.8 from
expected), change of +26.0 (+22.9 from
expected change)
```

The other format for entries in the outlier list is used to draw attention to the observed time series remaining constant when natural variability would be expected. If the value does not change for 5 or more consecutive days, it is flagged as a potential problem. The message structure and format are shown below.

```
Station STA_NUM, MM-DD-YYYY, DATA_VALUE
reported same value five or more days in a
row
```

In this entry, STA_NUM is the station number, MM-DD-YYYY is the date, and DATA_VALUE is the station's measured data value as read from the file. The following example shows that station 6 reported 61.0 degrees for 5 or more days, including April 24, 2011.

```
Station 6, 04-4-2011, 61.0 reported same
value five or more days in a row
```

For temperature data, there are two additional entry formats used in the outlier listing. If the daily temperature range is unusually large or unusually small, the entry will be structured as the "Station 31" below from March 6, 1996, which had a high temperature of 50 degrees, a low of –11 degrees, and a daily temperature range (DTR) of 61 degrees. High DTRs are flagged if they are greater than 60 degrees. Low DTRs are flagged only if TMAX is less than TMIN.

```
Station 31, 03-06-1996, (MAX - MIN) = 50.0
- -11.0 = 61.0
```

If a station has a value on a certain day for TMAX or TMIN, but not both, an entry formatted as the following will be added to the list. In this instance, station 31 reported a TMIN value but not a TMAX value.

```
Station 31, 10-21-1998, MIN without MAX
```

At the end of the outlier list, a total count is given for high DTR, low DTR, and values missing for either TMAX or TMIN but not the other.

PrmsDiff

PrmsDiff is used to compare measured climate-data files that are used as input to Draper (the files use PRMS data format and are described further in appendix 5). For example, PrmsDiff is useful for comparing a data file that has been edited with OutlierFinder to identify changes from the original file's values. PrmsDiff writes a report of its findings in a flat file. PrmsDiff is installed as part of the OutlierFinder directory and has the same system requirements, with the exception that it does not require any graphics capabilities.

To use PrmsDiff, copy the two PRMS files into the OutlierFinder directory. Click to select the first file, hold CTRL while clicking to select the second file, and then drag and drop the two selected files onto the PrmsDiff.bat file. A console window will appear briefly, and a plain-text report will be written to a file named PrmsDiff.out

For each station value that differs between the files, a line is written in the PrmsDiff.out file. The changes are reported in terms of how the second file differs from the first. For values that have been removed, the line takes the form below.

```
Value removed at YYYY-MM-DD Station STA_
NUM (OLD_VALUE)
For this line,
YYYY-MM-DD is the date,
STA_NUM is the station number,
OLD_VALUE is the value in the first file
that was deleted in the second.
```

An example of this type of line could look like the following line:

```
Value removed at 2014-02-25 Station 20 (
68.00)
```

For values that have changed, the line takes the form of the line below.

```
Value changed at YYYY-MM-DD Station STA_
NUM (OLD_VALUE) to (NEW_VALUE)
For this line,
YYYY-MM-DD is the date as a four digit
year, two digit month, and two digit day
STA_NUM is the station number
OLD_VALUE is the value from the first file
NEW_VALUE is the value from the second
file.
```

An example of this type of line could look like the following line:

```
Value changed at 1966-11-07 Station 20
(29.00) to (41.00)
```

Data-Evaluation Tools for Draper Output

DtrChecker

DtrChecker is used to check the DTR between Draper TMIN and TMAX climate-data output (estimated) values for HRUs. DtrChecker prints a report of the days and the HRUs' climate-data values that were below the minimum degree threshold. DtrChecker also can modify the TMIN climate-data output file so that the TMAX and TMIN climate-data output values meet the preset threshold.

DtrChecker can be run from a batch file in the same directory as draper.exe. The OutlierFinder subdirectory also must be in that directory (see the section "Data-Evaluation Tools for Draper Input"). The batch file should have the form shown below.

```
@echo off
java -cp DraperManager.jar gov.usgs.cawsc.
Draper.DtrChecker BASIN HRU_COUNT DEGREE_
THRESHOLD MODIFY_TMIN %* > REPORT_FILE
echo.
echo Press any key to close...
pause > nul
```

where

BASIN is the basin folder name,

HRU_COUNT is the number of HRUs in the output,

DEGREE_THRESHOLD is the lowest daily temperature range that is considered acceptable,

MODIFY_TMIN is a true/false value determining whether the TMIN data file should be modified to force the DTR to meet or exceed the allowable value, and

REPORT_FILE is the name of the flat file where the report is written.

For example, for the Merced River Basin model, values for the above listed key arguments were as listed below.

BASIN = MERCED
HRU_COUNT = 659
DEGREE_THRESHOLD = 15
MODIFY_TMIN = true
REPORT_FILE = DtrCheckerMerced.out

If MODIFY_TMIN is true, TMIN values will be lowered until the DTR at each HRU is larger than the specified threshold. For example, the batch file DtrCheckerMerced.bat follows the lines below.

```
@echo off
java -cp DraperManager.jar gov.usgs.cawsc.
Draper.DtrChecker MERCED 659 15 true %* >
DtrCheckerMerced.out
echo.
echo Press any key to close...
pause > nul
```

The REPORT_FILE contains a line for each day that the DTR did not meet the threshold. These lines are formatted according to the structure below.

```
Substituting values on YYYY M D: [HRU_
COUNT] (HRU_NUM, OLD_VAL-> NEW_VAL)
```

where

YYYY M D is the year, month, and day and

HRU_COUNT is the number of HRUs that exceeded the threshold.

The part within parentheses is repeated for each HRU that exceeded the threshold, with HRU_NUM being the HRU number, OLD_VAL being the old TMIN value, and NEW_VAL being the new TMIN value.

The example DtrChecker report line below shows that on December 14, 1948, two HRUs had a DTR that did not meet the minimum threshold. The first was HRU 519 and its TMIN value was adjusted down from 32 to 31 degrees. The second was HRU 527 and its TMIN value was adjusted down from 31 to 30 degrees.

```
Substituting values on 1948 12 14: [ 2]
(519, 32-> 31) (527, 31-> 30)
```

The example report written to DtrCheckerMerced.out looks like the lines below.

```
Daily Temperature Range Checker 2015-09-10
MERCED, 659 HRUs
Threshold < 15, Fix = true
Substituting values on 1948 12 14: [ 2]
(519, 32-> 31) (527, 31-> 30)
Substituting values on 1948 12 27: [ 2]
(519, 32-> 31) (527, 31-> 30)
Substituting values on 1949 12 18: [ 2]
(519, 32-> 31) (527, 31-> 30)
```

DtrChecker Read-Only Mode

DtrChecker can be run in a read-only mode to better understand the DTR values that are calculated by Draper without modifying climate-data output values of minimum temperature. If the threshold is zero, DtrChecker simply checks that TMAX is never less than TMIN. The sample batch file below is named DtrCheckerThreshold.bat and uses the read-only mode by setting MODIFY_TMIN = false. It writes a report to a file but doesn't modify the temperature data.

```
@echo off
java -cp DraperManager.jar gov.usgs.cawsc.
Draper.DtrChecker MERCED 659 0 false %* >
DtrCheckerThreshold.out
echo.
echo Press any key to close...
pause > nul
```

The report contains a line for each day that the DTR did not meet the threshold. These lines are formatted according to the structure below.

```
Threshold exceeded on YYYY M D: [HRU_
COUNT] (HRU_NUM, TMIN_VAL.. TMAX_VAL)
```

where

YYYY M D is the year, month, and day and

HRU_COUNT is the number of HRUs that exceeded the threshold.

The part within parentheses is repeated for each HRU that exceeded the threshold, with HRU_NUM being the HRU number, TMIN_VAL being the TMIN value, and TMAX_VAL being the TMAX value.

The output from the run would look like the following script. For each day that the TMIN exceeds TMAX at an HRU, DtrChecker writes the HRU numbers and TMIN and TMAX values.

```
Daily Temperature Range Checker 2015-09-10
MERCED, 659 HRUs
Threshold < 15, Fix = false
Threshold exceeded on 1948 12 14: [ 2]
(519, 32.. 46) (527, 31.. 45)
Threshold exceeded on 1948 12 27: [ 2]
(519, 32.. 46) (527, 31.. 45)
Threshold exceeded on 1949 12 18: [ 2]
(519, 32.. 46) (527, 31.. 45)
```

Diagnostic Spreadsheet

The diagnostic spreadsheet is written for each climate-data variable type as CSV and may be imported directly into Excel or other spreadsheets. One effective way to view the data is to sort the columns using Excel's filtering feature. To turn on filtering, click the Data tab and then the Filter button. To make all column names readable, click column header A, Shift-click column header T, and double-click one of the separator lines between the column headers. The buttons for sorting each column are visible next to each column heading (fig. 19). See appendix 7 for more details on the contents of the spreadsheet.

To view extreme values, scroll to the top, click on the column-header drop-down arrow, and choose "Sort Largest to Smallest" or "Sort Smallest to Largest." A small arrow will indicate which column is sorted.

Outliers in Draper computations may be found by sorting Draper Min, Draper Mean, or Draper Max columns. If a value computed by Draper is suspect, it may be possible to diagnose the cause by looking for contributing factors in other columns, such as the slope of the regression plane (Slope), or the measured minimum (Meas Min) and maximum (Meas Max).

Gr Diagnostic Viewer of Time-Series Graphs

Data in the diagnostic spreadsheet also may be viewed as time-series graphs using the Gr (pronounced as the letters "G-R") graphing tool (Donovan, 2010). All files needed to view Draper diagnostic output in Gr are provided with the Draper Suite distribution. See the subdirectory called .\DRAPER_RELEASE_20170327_REVIEW_INPUT_ONLY\Gr\.

To view the time-series data from the diagnostic spreadsheet, launch "view_diag_in_gr.bat" file in the GR_DIAG_PPT directory, in the data-type subdirectory. It will read the file ending with "_DIAG.csv"—for example, the file MERCED_PPT_DRAPER_DIAG.csv—and open a graph window (fig. 20). The columns from the spreadsheet are displayed in graphs that are grouped into three "pages," which Gr displays one at a time (figs. 20, 21, 22).

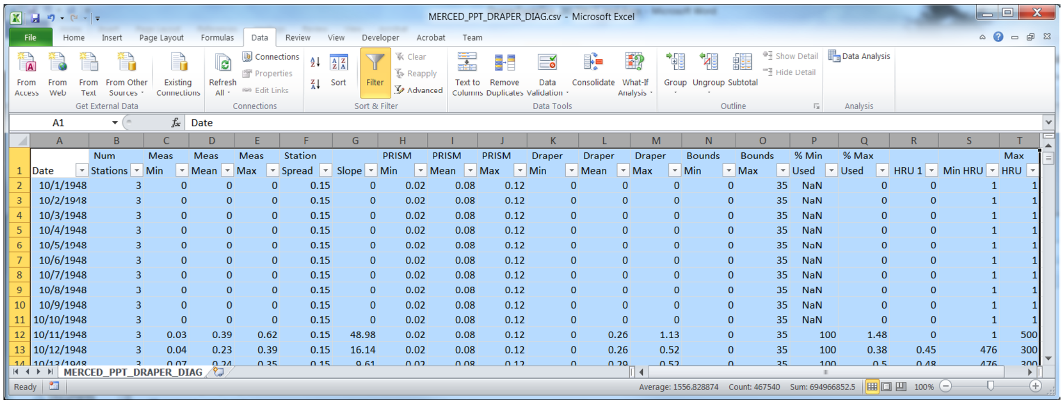
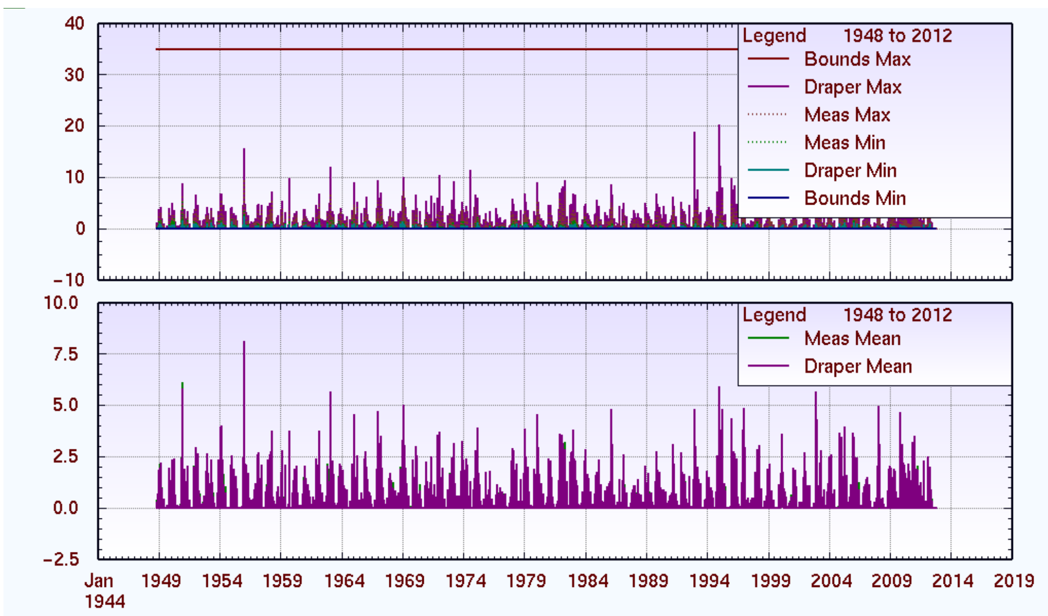
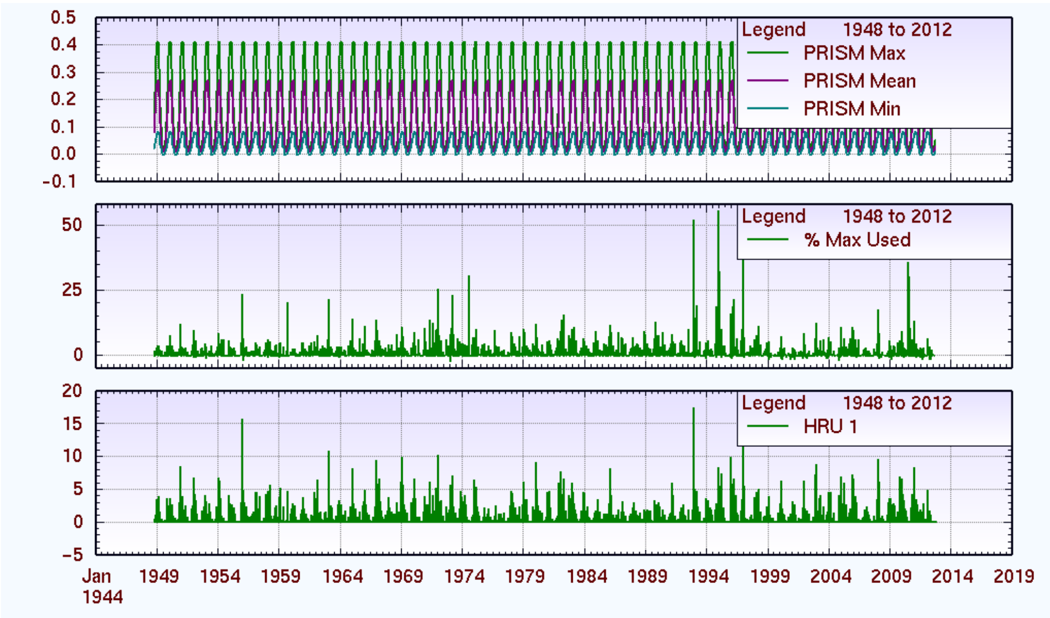


Figure 19. Example diagnostic spreadsheet in Excel with the Filter button highlighted on the Data menu tab. The buttons for sorting each column are visible next to each column heading.



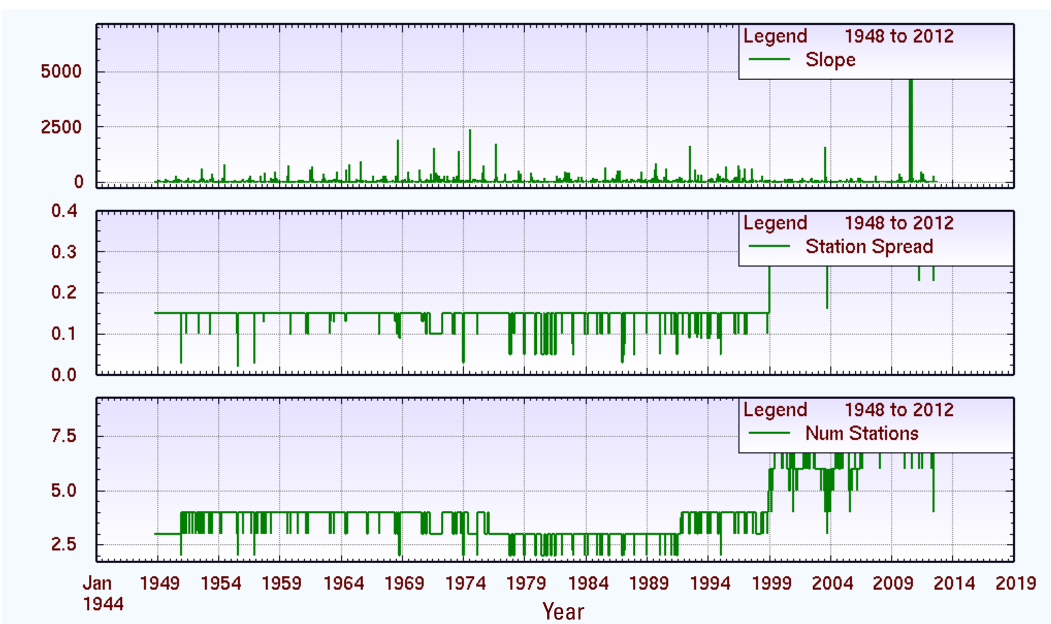
Note: Data shown are for the purpose of example and should not be used or interpreted for any other purpose.

Figure 20. First page of graphs from the example diagnostic spreadsheet, as displayed by the Gr graphing tool. The lower graph displays the measured mean and Draper mean time series. The upper graph displays the bounds maximum, the Draper maximum, the measured maximum, the measured minimum, the Draper minimum, and the bounds minimum (example uses MERCED_PPT_DRAPER_DIAG.csv as input).



Note: Data shown are for the purpose of example and should not be used or interpreted for any other purpose.

Figure 21. Second page of graphs from the example diagnostic spreadsheet, as displayed by the Gr graphing tool. The top graph displays the Parameter-elevation Regressions on Independent Slopes Model (PRISM) maximum, mean, and minimum. The middle graph displays the "% (percent) Max Used" column from the spreadsheet, and the lower graph displays the values calculated by Draper for hydrologic response unit 1.



Note: Data shown are for the purpose of example and should not be used or interpreted for any other purpose.

Figure 22. Third page of graphs from the example diagnostic spreadsheet as displayed by the Gr graphing tool. The top graph displays the "Slope" column from the spreadsheet; the middle graph displays the "Station Spread" column from the spreadsheet; and the lower graph displays the "Num Stations" (number of active stations) column from the spreadsheet.

To view a different page, use Alt-Left Arrow, Alt-Right Arrow, or the Page Next button on the toolbar (fig. 23*C*). The name of the page is shown in the window's title bar. The pages are named with the data type followed by "Num Stations, Slope, PRISM, Means," "Min and Max," and "Out of Bounds." When viewing the TMIN or TMAX diagnostics, some minimums are shown that are not shown for PPT.

The legend on each graph shows which columns from the spreadsheet are included and the line pattern used. The date axis for all graphs is shown along the bottom graph (fig. 23*E*).

To view a certain period in more detail, move the mouse along the X axis until a pointer appears with a vertical line. Click and drag the mouse to define the new period. For example, if years 1954 to 1958 are shown and 1955 to 1957 are desired, click along the X axis at 1955, drag the mouse to 1957, and release (fig. 24).

To zoom out, hover the mouse over the corner of the axis and click one of the buttons that appear (fig. 25). The "<" button zooms out part way. The "<<" zooms out to the full data extent. The bottom left corner zoom button is "Zoom All" for both the X and Y axes.

The X axes of the graphs on all three pages are linked, so if you zoom or pan to a certain period on one page, and then click Page Next to view the next page, the same period will be shown on all graphs.

To pan, click and drag the mouse in the graph area. Panning is allowed just past the extents of the data.

The Lock button appears when hovering the mouse at the edge of an axis. It locks the axis, which can be convenient for locking the Y axis while clicking and dragging to pan on the X axis.

To hide a graph, click on the graph and a green marker will show along the left side of the graph. Click the Graph > Hide button on the toolbar. To redisplay hidden graphs, click the Graph > Show button, which will display the next hidden graph, in order from bottom to top.

To hide a legend, click on the graph, right-click, and choose Graph -> Hide Legend. A Page can be deleted from the list using the Page Delete button on the toolbar.

A time series may be copied and pasted to another graph by right-clicking it, choosing Curve -> Copy, and then clicking on the destination graph, right-clicking, and choosing Curve -> Paste. The color, thickness, and line pattern of a curve can be changed by right-clicking on the curve and choosing the desired attributes from the Curve submenu (fig. 26). On each attribute submenu, the current value is marked with an asterisk.

The page can be printed by clicking the Save > As PS… (for postscript) button on the toolbar and choosing a file name. The resulting PostScript file can be viewed or converted to PDF format using a third-party utility. The page as currently shown can be saved to an XML file and then either sent to a colleague to view in Gr or reopened later in Gr.

Note: Data shown are for the purpose of example and should not be used or interpreted for any other purpose.

Figure 23. Gr tool showing time-series graphs displaying data from the diagnostic spreadsheet, including the *A,* Title Bar, *B,* Graph Area, *C,* Tool Bar with Page Next Button, *D,* Legend, *E,* Date Axis, and *F,* Status Bar.

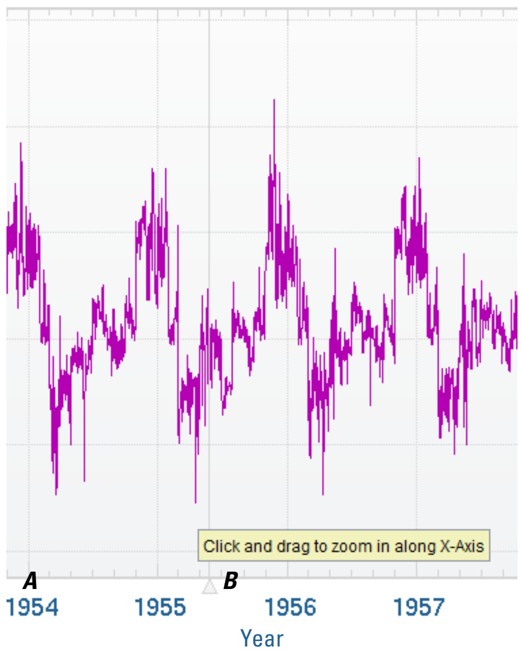


Figure 24. Detail of the Gr tool showing the *A,* date axis and *B,* zoom pointer.

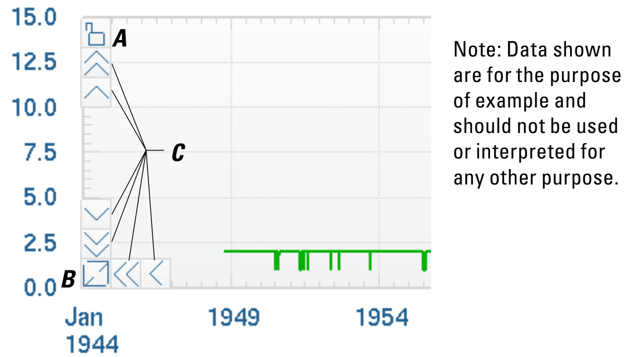


Figure 25. Detail of the Gr tool showing the *A,* mouse-hover axis lock button, *B,* the mouse-hover axis zoom-all button, and *C,* the mouse-hover axis zoom-out buttons.

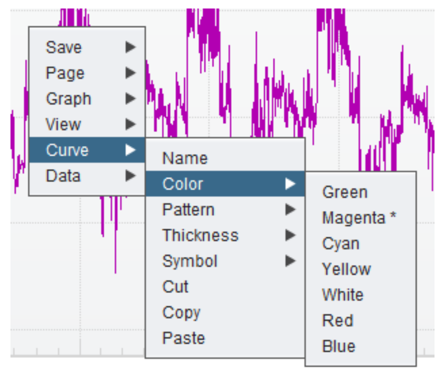


Figure 26. Detail of the Gr tool showing the right-click menu for curve color.

Iterative Processing for Best Results

Using Draper Suite to prepare climate-data input files for a physically based environmental model is best handled as an interactive process (fig. 27). Before running Draper, check measured climate data for anomalies and whether the upper and lower ranges set in Draper are too tight or too loose. Carefully review the gridded climate surfaces used to normalize the daily climate measurements. In our case study, we use 1981–2010, 30-year mean-monthly PRISM data. The following are some questions to consider: (1) Do these climate surfaces reasonably represent the monthly climate trends of the study area?; (2) Do these correspond to the same timeframe as the desired PRMS simulations?; and (3) Are there better climate surfaces that are more appropriate to use for the study area and timeframe?

During the iterative process, to achieve the best calibration, we would review model simulations and investigate streamflow hydrograph spikes that are substantially different in magnitude between simulated and observed streamflows, for example, from precipitation-runoff models such as PRMS. By paying attention to these considerations and employing Draper and its pre- and post-processing toolset, the operator may successfully create climate-data files to drive physically based environmental models with a good understanding of the strengths and limitations of their climate datasets.

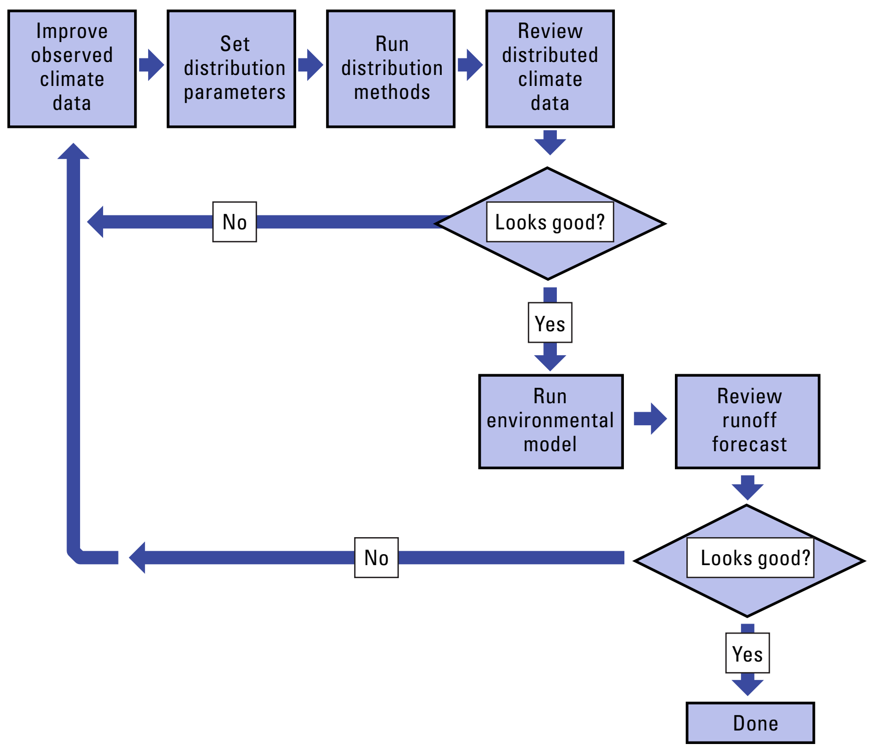


Figure 27. Workflow of the iterative process to optimize input climate datasets for runoff forecasting.

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Markstrom, S.L., Regan, R.S., Hay, L.E., Viger, R.J., Webb, R.M.T., Payne, R.A., and LaFontaine, J.H., 2015, PRMS-IV, the precipitation-runoff modeling system, version 4: U.S. Geological Survey Techniques and Methods, book 6, chap. B7, 158 p., accessed December 7, 2018, at https://doi.org/10.3133/tm6B7.

Glossary

Climate-data output file Results from Draper runs for PPT, TMIN, or TMAX data; these files are formatted for PRMS input.

Cmd Microsoft Windows command-line interface launched using cmd.exe.

Draper Suite Draper Climate-Distribution Software Suite. The suite of software described in this user's manual.

DTR Daily temperature range, the range used to identify upper and lower bounds of daily temperature simulations generated by Draper.

HRU Hydrologic Response Unit, the modeling mapping unit of PRMS.

Model-Mapping Unit The discrete unit in a physically based environmental model that is assumed to be homogeneous for physical characteristics and response to climate and runoff.

PPT Precipitation, the total precipitation at a given location during a defined period.

PRMS Precipitation-Runoff Modeling System, a deterministic, distributed-parameter, physical process based (physically based) watershed modeling system developed to evaluate the response of various combinations of climate and land use on streamflow and general watershed hydrology (Markstrom and others, 2015).

PRMS formatted file Time-series data for multiple locations, formatted for PRMS.

TMAX Maximum temperature at a given location during a 24-hour period that, unless otherwise noted, begins at midnight.

TMIN Minimum temperature at a given location during a 24-hour period that, unless otherwise noted, begins at midnight.

Appendix 1. CalcSigma—Standard Deviations for Draper Input and Station Accuracy Assessment

In statistics, standard deviation is denoted by the Greek letter σ (sigma). Therefore, the CalcSigma program calculates the standard deviation of daily temperatures used by Draper to make the temperature climate-data output files from measured station input and Parameter-elevation Regressions on Independent Slopes Model (PRISM) averages for each modeling mapping unit. In the Merced River Basin Precipitation-Runoff Modeling System (PRMS) example, the modeling mapping unit is the hydrologic response unit (HRU). The output for the mapping unit is written to separate files for each data type.

Modeling mapping unit area files with standard deviation for the maximum daily temperature (TMAX) and minimum daily temperature (TMIN) are below.

MERCED_TMAX_PRISM_SIGMA,
MERCED_TMIN_PRISM_SIGMA

CalcSigma can optionally be used to create another set of files containing standard deviations at the climate-station locations.

Climate-station location files with standard deviation for TMAX and TMIN are below.

MERCED_TMAX_STA_PRISM_SIGMA,
MERCED_TMIN_STA_PRISM_SIGMA

These standard deviations are used by Draper to calculate climate-data output values at the station locations, which in turn are used to determine the differences with the measured input at the stations. Statistics on the differences are printed by Draper to the *STA_DIFFS file.

For the Merced River Basin PRMS example, the Draper output files are named below.

MERCED_PPT_STA_DIFFS
MERCED_TMAX_STA_DIFFS
MERCED_TMIN_STA_DIFFS

Installation

CalcSigma.exe is a standalone executable that should be installed in the same directory as draper.exe. CalcSigma is written in Fortran and shares certain source code routines with Draper. These routines are compiled into the executable, however, so draper.exe is not required to be present at run time.

Running the Program

To run CalcSigma, double-click the CalcSigma.exe executable. A console window will appear and prompt for the study-area name to be entered, followed by the subfolder. The next prompt asks for a prefix to be entered or to press Enter if there is none. If the user presses enter, the prefix will be blank, and the program will read from a file named like `<BASIN>_<SUB>_DAILIES` and write to a file named `<BASIN>_<SUB>_PRISM_SIGMA`. If a value is typed for the prefix, the program will read from a file named `<BASIN>_<SUB>_<PREFIX>_DAILIES` and write to a file named `<BASIN>_<SUB>_<PREFIX>_PRISM_SIGMA`. When the prefix value is used, it is most often set to "STA" to calculate the standard deviation at station locations which Draper does not require, but when present is used to determine the differences between measured and calculated values at the station locations.

As the program runs, it writes the dates as it progresses through the calculations. The console window will disappear when it is finished. If the output is not written out, the program should be rerun from a Cmd window, so the user can read any error messages that may be written. The program will stop with an error message if it can't find the input file, if it can't find a line beginning with # to identify the end of the header in the input file, or if an input data value is missing.

Input Files

The input file contains daily temperature data at each location where Draper will make a temperature calculation (HRUs or, optionally, station locations). The header of the input file should look like the below:

```
STA_ID XX1 XX2 ...
numLocs=NUM_LOCS
#####
```

where

`XX1` and `XX2`	are station names or numbers in the order they will appear in the data columns below and
`NUM_LOCS`	is the number of locations (columns) in the file.

The data lines in the file should have the format below:

```
YYYYMMDD VAL1 VAL2 ...
```

where

`YYYYMMDD`	is the date and
`VAL1` and `VAL2`	are the location values.

Output Files

CalcSigma writes a standard deviation value for each month at each location. After the header, the output file contains a line of values for each location. The first column is the location number followed by columns for the months of January through December. An example is shown below where column 1 is the HRU value; the following columns are the 30-year mean-monthly PRISM values for each HRU.

```
30-year Mean Monthly Standard Deviation of Daily PRISM values at each location
########
 1 7.9 8.7 8.9 10.1 10.0 8.6 5.7 5.4 8.5 9.7 9.2 7.8
 2 8.8 9.4 9.2 10.2 10.2 8.8 5.9 5.4 8.6 9.8 9.6 8.8
 3 9.0 9.5 9.3 10.2 10.2 8.9 5.9 5.5 8.7 9.8 9.7 8.9
 4 9.0 9.5 9.3 9.5 9.2 8.1 5.3 4.9 7.6 9.0 9.6 8.9
 5 7.5 8.3 8.9 10.3 10.2 8.9 6.0 5.6 8.5 9.9 9.1 7.6
 6 8.9 9.5 9.3 9.6 9.4 8.2 5.5 5.0 7.7 9.2 9.6 8.8
 7 8.7 9.2 9.1 10.0 9.9 8.5 5.6 5.3 8.4 9.7 9.5 8.5
 8 6.2 6.9 8.0 9.4 9.4 7.9 5.5 5.4 7.9 8.9 8.2 6.4
 9 8.3 9.1 9.1 10.2 10.0 8.5 5.6 5.4 8.6 9.8 9.5 8.1
 10 7.5 8.3 8.8 9.9 9.8 8.5 5.5 5.2 8.2 9.6 9.0 7.5
```

Appendix 2. Directory Architecture and File Locations of the Release Packages, Including Example Datasets for Merced River Basin Precipitation-Runoff Modeling System

This appendix contains two versions of the Draper release package. One version contains example Draper input files prepared for the Merced River Basin Precipitation-Runoff Modeling System (PRMS) but does not include any example outputs. The second version of the release package includes examples of both Draper inputs and outputs for the Merced River Basin PRMS. A few items concerning the significance of type styles used to help users distinguish between directory names and filenames are (1) backslashes denote \directory\, (2) filenames are in *italics*, and (3) boldface (used in listing for release package B only) signifies output files.

Release Package A Contains Input Files Only

- \DRAPER_RELEASE_20170327_REVIEW_INPUT_ONLY\
    - *draper.exe*
    - *DraperManager.bat*
    - *DraperManager.jar*
    - *DraperManager_debug.bat*
    - *DraperMercedAll.bat*
    - *DraperMercedPPT.bat*
    - *DraperMercedTMAX.bat*
    - *DraperMercedTMIN.bat*
    - *DtrCheckerMerced.bat*
    - *DtrCheckerThresholdMerced.bat*
    - \DRAPER_SRC_EXE_20170327\
        - *CalcSigma.bat*
        - *CalcSigma.exe*
        - *calcSigma.f*
        - *draper.exe*
        - *draper.f*
        - *draper_subs.f*
        - *DraperManager.bat*
        - *DraperManager.jar*
        - *DraperManager.java*
        - *DraperManager_debug.bat*
        - *DtrCheckerMerced.bat*
        - *DtrCheckerThresholdMerced.bat*
        - *get_args.f90*
        - *interpol.f*
        - *inverse.f*
        - *to_upper.f90*
        - *trend.f*
- \DRAPER_RELEASE_20170329_REVIEW_INPUT_ONLY\ …
    - \Gr\
        - config\
        - lib\
        - samples\
        - *gr.bat*
        - *gr64X256.ico*
        - *grBathCalc.bat*

```
        grFilt.bat
        pauseBeforeClosing.bat
        relnotes.txt

    \MERCED\
        MERCED_CENTROIDS
        MERCED_NORM_POR
        readme.txt

        PPT\
                MERCED_MEAS_PPT.data
                MERCED_PPT_AVERAGES
                MERCED_PPT_LOCATIONS
                MERCED_PPT_RANGE
                MERCED_PPT_STA_AVERAGES

                GR_DIAG_PPT_MERCED\
                        GR_DIAG_PPT\
                                diag.grs
                                view_diag_in_gr.bat

    TMAX\
        MERCED_MEAS_TMAX.data
        MERCED_TMAX_AVERAGES
        MERCED_TMAX_LOCATIONS
        MERCED_TMAX_PRISM_SIGMA
        MERCED_TMAX_RANGE
        MERCED_TMAX_STA_AVERAGES
        MERCED_TMAX_STA_PRISM_SIGMA

        GR_DIAG_TMAX\
                diag.grs
                view_diag_in_gr.bat

\DRAPER_RELEASE_20170329_REVIEW_INPUT_ONLY\ …
    MERCED\
        TMIN\
                MERCED_MEAS_TMIN.data
                MERCED_TMIN_AVERAGES
                MERCED_TMIN_LOCATIONS
                MERCED_TMIN_PRISM_SIGMA
                MERCED_TMIN_RANGE
                MERCED_TMIN_STA_AVERAGES
                MERCED_TMIN_STA_PRISM_SIGMA

                GR_DIAG_TMIN\
                        diag.grs
                        view_diag_in_gr.bat

    OutlierFinder\
        OutlierFinder.bat
        OutlierFinder.jar
        PrmsDiff.bat
```

Release Package B Contains Input Files and Resulting Output Files

Backslashes denote \directory\. Input files are in *italics*. Output files are ***bold italics***.

\DRAPER_RELEASE_20170327_REVIEW_INPUT_OUTPUT\
draper.exe
DraperManager.bat
DraperManager.jar
DraperManager_debug.bat
DraperMercedAll.bat
DraperMercedPPT.bat
DraperMercedTMAX.bat
DraperMercedTMIN.bat
DtrCheckerMerced.bat
DtrCheckerMerced.out
DtrCheckerThresholdMerced.bat
DtrCheckerThresholdMerced.out

\DRAPER_SRC_EXE_20170327\
CalcSigma.bat
CalcSigma.exe
calcSigma.f
draper.exe
draper.f
draper_subs.f
DraperManager.bat
DraperManager.jar
DraperManager.java
DraperManager_debug.bat
DtrCheckerMerced.bat
DtrCheckerThresholdMerced.bat
get_args.f90
interpol.f
inverse.f
to_upper.f90
trend.f

\DRAPER_RELEASE_20170329_REVIEW_INPUT_OUTPUT …
\Gr\
config\
lib\
samples\
gr.bat
gr64X256.ico
grBathCalc.bat
grFilt.bat
pauseBeforeClosing.bat
relnotes.txt

\MERCED\
MERCED_CENTROIDS
MERCED_NORM_POR
readme.txt
PPT\
MERCED_DRAPER_PPT.data
MERCED_MEAS_PPT.data

MERCED_PPT_AVERAGES
MERCED_PPT_LOCATIONS
MERCED_PPT_RANGE
MERCED_PPT_STA_AVERAGES
MERCED_PPT_DRAPER_LOG
MERCED_PPT_STA_DIFFS
MERCED_PPT_DRAPER_DIAG.csv
MERCED_DRAPER_PPT_001.data
MERCED_DRAPER_PPT_001.diff

GR_DIAG_PPT_MERCED\
GR_DIAG_PPT\
diag.grs
view_diag_in_gr.bat

\DRAPER_RELEASE_20170329_REVIEW_INPUT_OUTPUT …
MERCED\
TMAX\
MERCED_DRAPER_TMAX.data
MERCED_MEAS_TMAX.data
MERCED_TMAX_AVERAGES
MERCED_TMAX_LOCATIONS
MERCED_TMAX_PRISM_SIGMA
MERCED_TMAX_RANGE
MERCED_TMAX_STA_AVERAGES MERCED_TMAX_STA_PRISM_SIGMA
MERCED_TMAX_DRAPER_LOG
MERCED_TMAX_STA_DIFFS
MERCED_TMAX_DRAPER_DIAG.csv
MERCED_DRAPER_TMAX_001.data
MERCED_DRAPER_TMAX_001.diff

GR_DIAG_TMAX\
diag.grs
view_diag_in_gr.bat
TMIN\
MERCED_DRAPER_TMIN.data
MERCED_MEAS_TMIN.data
MERCED_TMIN_AVERAGES
MERCED_TMIN_LOCATIONS
MERCED_TMIN_PRISM_SIGMA
MERCED_TMIN_RANGE
MERCED_TMIN_STA_AVERAGES
MERCED_TMIN_STA_PRISM_SIGMA
MERCED_TMIN_DRAPER_LOG
MERCED_TMIN_STA_DIFFS
MERCED_TMIN_DRAPER_DIAG.csv
MERCED_DRAPER_TMIN_001.data
MERCED_DRAPER_TMIN_001.diff

GR_DIAG_TMIN\
diag.grs
view_diag_in_gr.bat

OutlierFinder\
OutlierFinder.bat
OutlierFinder.jar
PrmsDiff.bat

Appendix 3. Status, Warning, and Error Messages

Status, warning, and error messages are printed to the console window and a log file (tables 3–1, 3–2, and 3–3).

Table 3–1. Draper Status Messages—General.

[MM/DD/YYYY, month/day/year; POR, period of record; PRISM, Parameter-elevation Regressions on Independent Slopes Model; YYYYMMDD, year month day]

Message	Additional explanation
DRAPER revision YYYYMMDD	The revision date of this version of Draper
Data read and bounds checked	
Calculating mean monthly differences...	
Normalizing Period of Record: [Dates...]	Writes the date range of the data that will be used for normalization
PRISM averages will be divided by number of days in month (for precip)	Indicates that this Draper run is for precipitation data
PRISM averages will NOT be divided by number of days in month (NOT for precip)	Indicates that this Draper run is for temperature data
Allowable bounds for values will be [VALUES]	Writes the upper and lower bounds that are considered acceptable for input and output
POR Start = [Dates...]	Writes the input Period of Record
Interpolated data through MM/DD/YYYY	Written once per year to indicate progress in calculating output
DRAPER run completed	Indicates that Draper has finished

Table 3–2. Draper Warning Messages—Console Window.

[MM/DD/YYYY, month/day/year; PRISM, Parameter-elevation Regressions on Independent Slopes Model]

Console message	Additional explanation
No station averages input found so not calculating mean monthly differences...	The station averages file was missing or contained no readable data.
Input out of bounds ([VALUE]) at MM/DD/YYYY	
RANGE file was not found Allowable bounds for values will be default	The RANGE file was not found, so default values will be used for upper and lower bounds.
WARNING: Switching to averaging method because regression plane produced out of range value ([VALUE]) on MM/DD/YYYY	Indicates that Draper method II will be used.
WARNING: Switching to PRISM mean because averaging method produced out of range value ([VALUE]) on MM/DD/YYYY	Indicated that Draper method III will be used.
WARNING: PRISM mean output out of range ([VALUE]) on MM/DD/YYYY	The mean value from PRISM was out of bounds. This may indicate that the bounds are too narrow.

Table 3–3. Draper Error Messages—Console Window.

[MAX, maximum; MIN, minimum; MM/DD/YYYY, month/day/year; PRISM, Parameter-elevation Regressions on Independent Slopes Model]

Screen message	Log file message	Additional explanation
UNTERMINATED INPUT HEADER	Could not find end of header in MEAS file. A line starting with # identifies end of header.	Stops the program because a line starting with # was not found in the measured input file.
UNTERMINATED INPUT HEADER	Could not find end of header in AVERAGES file. A line starting with # identifies end of header	Stops the program because a line starting with # was not found in the PRISM averages file.
MISSING INPUT	Station data missing at MM/DD/YYYY	Stops the program because the input data file did not have a value for each station on the given date.
INVALID INPUT		Stops the program because an input value was out of bounds.
ERROR READING RANGE FILE	Error while reading RANGE file. Expected line 1: comment, line 2: MIN MAX	Stops the program because the range file did not contain the expected format.

Appendix 4. Draper Command-Line Operation and Options

To run Draper from the command line, type “draper.exe” at the prompt of a Cmd window while in the main Draper directory. Draper can be run in an interactive mode where it prompts the user for input and writes status messages to indicate progress, or a non-interactive mode where input is specified using command-line arguments. In the non-interactive mode, draper.exe needs command-line arguments for “–basin” and “–subfolder.” If the -basin or -subfolder options are not specified, or if the draper.exe file is launched by double-clicking on it in a file-browser window, Draper will revert to the interactive mode.

The non-interactive mode is useful for scripting Draper runs from a batch file. Once a batch file is set up to run Draper, it can be quicker and easier to use than the interactive command-line interface. Several batch files are provided with the Draper installation as a convenience that allows running the program with certain input options simply by double-clicking the batch file; examples include DraperMercedAll.bat (runs all three data types for the Merced River basin), DraperMercedPPT.bat (runs daily precipitation, PPT, for the Merced River basin), DraperMercedTMAX.bat (runs maximum daily temperature, TMAX, for the Merced River basin), and DraperMercedTMIN.bat (runs minimum daily temperature, TMIN, for the Merced River basin).

The available command-line options for Draper are specified in table 4–1.

Table 4–1. Draper Command-Line Options.

[HRU, hydrologic response unit; PPT, daily precipitation; TMAX, daily maximum temperature; TMIN, daily minimum temperature]

Command line option	Description
-basin=<BASIN>	Specifies the basin folder to use for input and output.
-subfolder=<SUB>	Specifies the subfolder for the climate data type, such as PPT, TMAX, or TMIN.
-hruDiagNum=<NUM>	Specifies which HRU should have its values written to the diagnostic spreadsheet (see “Output Files” section). Default is HRU 1.
-debugHeader	Causes additional debug information to be written to the header of the Draper output.
-allowOutOfBounds	Causes all HRU output to be calculated, even if some HRUs values are out of bounds. Default is off, which means an out of bounds HRU value causes a warning message to be written and calculations to be stopped for that day.

Appendix 5. Input Files and Formats

Input files shared by all data types are below:

CENTROIDS Hydrologic response unit (HRU) centroid locations, in latitude and longitude (example file, MERCED_CENTROIDS).

NORM_POR Beginning and ending of the normalization period (optional). If not present, Draper defaults to use first and last date found in the time-series measured data (example file, MERCED_NORM_POR).

Input files for individual data types are below:

MEAS Time-series observations of measured or synthesized climate data at point locations (station locations), where precipitation units are in inches and temperatures units are in degrees Fahrenheit (no data = –99; example file, MERCED_MEAS_PPT.data).

AVERAGES Hydrologic response unit area-weighted mean-monthly Parameter-elevation Regressions on Independent Slopes Model (PRISM) values in inches for precipitation or degrees Fahrenheit for temperatures, sampled from each of the twelve 30-year mean-monthly PRISM surfaces (example file, MERCED_PPT_AVERAGES).

LOCATIONS Climate-station locations by latitude and longitude (example file, MERCED_PPT_LOCATIONS).

PRISM_SIGMA Hydrologic response unit area-weighted standard deviations of PRISM temperature values in degrees Fahrenheit computed from the 30-year mean-monthly PRISM surfaces (maximum daily temperature, TMAX; and minimum daily temperature, TMIN only; example file, MERCED_TMAX_PRISM_SIGMA).

RANGE Annual or monthly ranges (upper and lower bounds) of expected climate-data values (optional; example file, MERCED_PPT_RANGE).

STA_AVERAGES Station-location mean-monthly PRISM values in inches for precipitation or degrees Fahrenheit for temperatures, sampled from each of the twelve 30-year mean-monthly PRISM surfaces (TMAX and TMIN only; optional; example file, MERCED_TMAX_STA_AVERAGES).

STA_PRISM_SIGMA Station-location standard deviations of PRISM temperature values in Fahrenheit computed from the 30-year mean-monthly PRISM surfaces (TMAX and TMIN only; optional; example file, MERCED_PPT_STA_PRISM_SIGMA).

Input files AVERAGES, PRISM_SIGMA, STA_AVEARGES, and STA_PRISM_SIGMA are computed using Geographic Information Systems (GIS) software by sampling twelve 30-year mean-monthly PRISM surfaces of climate data (Daly and others, 1994; Di Luzio and others, 2008) at station locations or for hydrologic response unit (HRU) areas. A value of "–99" is used to denote missing values in the MEAS time-series station data.

Examples of files formats used to make climate-data inputs for Merced River Basin Precipitation-Runoff Modeling System (PRMS; table 1) are provided in the remainder of this appendix.

File Examples

Centroids—HRU Centroid Locations

The station count must be on line one. Data column 1 lists the HRU identification in sequential order, column 2 holds latitude, and column 3 holds longitude. For example, the full listing has been truncated, as is noted by a row with "…".

Example file, **MERCED_CENTROIDS**

```
659
```

```
1 37.635302 119.349885
2 37.639698 119.376463
3 37.647888 119.390733
4 37.656614 119.394518
5 37.657007 119.323781
…
655 37.487026 120.339215
656 37.498497 120.470368
657 37.535334 120.540320
659 37.395253 120.775281
```

NORM_POR—Beginning and Ending of the Normalization Period

The comment line is noted as //. Data row 1 holds the beginning date as year, month, and day. Data row 2 holds the ending date as year, month, and day.

Example file, **MERCED_NORM_POR**

```
// MERCED Normalization Period: Start: yyyy m d End: yyyy m d
1985 10 1
2010 9 30
```

MEAS—Climate-Station Time-Series Measured Data

The example is showing daily precipitation for 15 stations. The first row is always a comment line and other comment lines begin with "//." The pound signs (#) demarcate header above and data below. Data columns 1–6 hold time-stamp information as year, month, day, hour, minute, and second, and columns 7–21 hold daily station values from the 15 stations. Station-data columns must be in the same order as the stations listed in the LOCATIONS file (example file, MERCED_PPT_LOCATIONS). For example, the full record has been truncated and is noted as a row with "…".

Example file, **MERCED_MEAS_PPT.data**

Merced Precipitation Data

```
//Stations: DCC DUC DDL FA6724EE 42920 C148 44113 MBB EXC 44115 48380 FA673798 YYV YOW
49855
// Sources: DWR-CDEC, NOAA-NCDC , CIMIS
// Units = inches
// Nodata = -99
// NOTE: Measured data. Called in OUI for comparison purposes.
// Used in DRAPER to generate output file: MERCED_DRAPER_PPT.data
// Period of Record: 10/1/1948 thru 9/30/2013
precip 15
################################################################
1948 10 1 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 2 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 3 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 4 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 5 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 6 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 7 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 8 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 9 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
1948 10 10 0 0 0 -99 -99 0.00 -99 -99 -99 -99 -99 -99 -99 0.00 -99 -99 -99 0.00
…
2013 9 21 0 0 0 0.00 0.00 -99 0.68 -99 0.00 -99 0.08 -99 0.16 -99 1.01 0.87 1.03 -99
```

```
2013 9 22 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.01 0.00 0.00 -99
2013 9 23 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 0.00 0.00 -99
2013 9 24 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 0.00 0.00 -99
2013 9 25 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 0.00 0.00 -99
2013 9 26 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 0.00 0.00 -99
2013 9 27 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 0.00 0.01 -99
2013 9 28 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 0.00 0.00 -99
2013 9 29 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 0.00 0.00 -99
2013-9-30 0 0 0 0 0.00 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 -99 0.00 0.00 0.00 -99
```

AVERAGES—Hydrologic Response Unit Area-Weighted Mean-Monthly Parameter-Elevation Regressions on Independent Slopes Model Values

The example shows monthly precipitation in inches for 659 HRUs. Pound signs demarcate header above and data below. Data column 1 lists the HRU identification in sequential order. Columns 2–13 hold monthly values starting with January (column 2) and ending with December (column 13). For example, the full record has been truncated and is noted as a row with "…".

Example file, **MERCED_PPT_AVERAGES**

```
Merced PRISM PPT 1981-2010 30-year mean-monthly totals. Units = inches.
HRU ppt_jan ppt_feb ppt_mar ppt_apr ppt_may ppt_jun ppt_jul ppt_aug ppt_sep ppt_oct
ppt_nov ppt_dec
################################
1 12.23 10.26 8.27 3.87 2.74 0.69 0.67 0.42 1.42 2.75 4.92 10.92
2 11.91 11.00 9.03 4.56 2.97 0.72 0.61 0.41 1.23 2.80 4.97 10.78
3 12.06 10.85 9.11 4.74 3.04 0.75 0.60 0.41 1.13 2.91 5.33 10.77
4 11.60 10.34 8.86 4.64 2.92 0.77 0.59 0.41 1.09 3.00 5.43 10.17
5 10.74 9.20 7.61 3.79 2.51 0.66 0.65 0.42 1.36 2.52 4.79 9.96
6 9.77 8.30 7.10 3.44 2.33 0.62 0.61 0.41 1.22 2.46 4.60 9.28
7 9.75 8.38 6.99 3.52 2.30 0.63 0.60 0.40 1.16 2.51 4.64 9.25
8 10.93 9.48 7.84 3.99 2.61 0.75 0.62 0.41 1.38 2.43 4.53 9.76
9 9.01 7.73 6.36 3.30 2.12 0.61 0.57 0.40 1.15 2.36 4.38 8.29
10 8.73 7.99 6.60 3.49 2.23 0.63 0.56 0.39 1.05 2.45 4.50 8.23
......
650 3.66 3.11 3.21 1.48 0.66 0.17 0.03 0.03 0.27 1.08 1.95 2.85
651 3.76 3.20 3.28 1.52 0.68 0.18 0.03 0.03 0.28 1.10 2.02 2.93
652 3.11 2.67 2.70 1.25 0.59 0.14 0.04 0.03 0.25 0.89 1.57 2.45
653 3.39 2.88 2.96 1.36 0.63 0.15 0.03 0.03 0.27 0.98 1.76 2.66
654 2.68 2.29 2.08 1.01 0.52 0.10 0.02 0.02 0.22 0.71 1.32 2.00
655 3.08 2.63 2.68 1.23 0.60 0.13 0.04 0.03 0.26 0.86 1.54 2.42
656 2.80 2.37 2.36 1.09 0.53 0.10 0.04 0.02 0.28 0.77 1.36 2.22
657 2.80 2.37 2.36 1.08 0.53 0.10 0.04 0.01 0.28 0.77 1.34 2.23
658 3.30 2.72 2.89 1.30 0.61 0.13 0.04 0.02 0.30 0.91 1.64 2.57
659 2.53 2.33 2.02 0.92 0.51 0.10 0.01 0.02 0.24 0.70 1.26 1.96
```

LOCATIONS—Climate-Station Locations

Station count must be entered on line 1. Each line of data represents one station and must be in the order of data shown in the MEAS file (example file, MERCED_MEAS_PPT). Column 1 holds latitude, and column 2 holds longitude. Column 3 holds identification information or other comments and is not read by Draper.

Example file, **MERCED_PPT_LOCATIONS**

```
15
37.654000 120.312000 Dry Creek near Coulterville - DCC
37.740590 120.132500 Dudley Ranch below Coultierville - DUC
37.720910 120.096140 Dudleys (McDiarmid Fire Station) - DDL
37.675556 119.786111 El Portal - FA6724EE
37.585000 120.267222 Exchequer Dam - 42920
37.313611 120.386389 Merced #148 - C148
37.652778 120.088333 Merced River - 44113
37.598900 119.978100 Merced River near Briceburg - MBB
37.585000 120.270000 New Exchequer, Lake McClure - EXC
37.800556 120.100833 Smith Peak - 44115
37.507500 119.633611 South Entr Yosemite - 48380
37.540000 119.651944 Wawona - FA673798
37.749950 119.589660 Yosemite at Yosemite Valley - YYV
37.508010 119.633620 Yosemite near Wawona - YOW
37.750000 119.589722 Yosemite NP - 49855
```

PRISM_SIGMA—Hydrologic Response Unit Area-Weighted Standard Deviation of Parameter-Elevation Regressions on Independent Slopes Model Daily Temperature Values

The example shows daily maximum temperature values in degrees Fahrenheit for 659 HRUs. Pound signs demarcate header above and data below. Data column 1 lists the HRU identification in sequential order. Columns 2–13 hold monthly values starting with January (column 2) and ending with December (column 13). For example, the full record has been truncated and is noted as a row with "…".

Example file**, MERCED_TMAX_PRISM_SIGMA**

```
Mean Monthly Standard Deviation of Daily PRISM values at each location
########
 1 9.1 9.6 9.5 10.0 9.6 8.5 5.6 5.3 8.4 9.8 9.9 9.0
 2 9.2 9.7 9.5 10.0 9.6 8.5 5.6 5.4 8.5 9.8 9.9 9.1
 3 9.3 9.7 9.5 10.0 9.6 8.5 5.6 5.4 8.5 9.8 9.9 9.1
 4 9.3 9.7 9.5 10.0 9.6 8.5 5.6 5.4 8.5 9.8 9.9 9.1
 5 9.0 9.5 9.4 10.0 9.6 8.5 5.6 5.3 8.4 9.8 9.8 8.9
 6 9.0 9.4 9.4 10.0 9.6 8.5 5.6 5.3 8.4 9.8 9.8 8.9
 7 9.0 9.5 9.4 10.0 9.6 8.5 5.6 5.3 8.5 9.8 9.8 8.9
 8 9.2 9.6 9.4 9.9 9.6 8.5 5.6 5.3 8.4 9.8 9.9 9.0
 9 9.0 9.4 9.4 10.0 9.6 8.5 5.6 5.3 8.4 9.8 9.8 8.9
 10 9.0 9.4 9.4 10.0 9.6 8.5 5.6 5.4 8.5 9.8 9.8 8.9
…
 649 5.5 6.4 7.5 9.0 9.1 8.0 5.8 5.6 7.7 8.4 7.5 5.6
 650 5.6 6.5 7.5 9.0 9.1 8.0 5.8 5.6 7.8 8.5 7.5 5.6
 651 5.6 6.6 7.6 9.0 9.2 8.0 5.7 5.6 7.8 8.5 7.6 5.6
 652 5.4 6.3 7.3 8.9 9.0 7.9 5.8 5.6 7.7 8.3 7.4 5.5
 653 5.5 6.3 7.4 8.9 9.1 8.0 5.8 5.6 7.7 8.4 7.4 5.5
 654 5.8 5.7 6.9 8.5 8.8 7.9 6.0 5.8 7.5 7.9 7.0 5.8
 655 5.4 6.1 7.2 8.8 9.0 7.9 5.8 5.6 7.6 8.3 7.3 5.5
 656 5.5 5.8 7.0 8.7 8.9 7.9 5.9 5.7 7.5 8.1 7.1 5.5
 657 5.5 5.8 6.9 8.6 8.8 7.9 6.0 5.8 7.5 8.0 7.1 5.6
 658 5.4 6.3 7.3 8.9 9.1 8.0 5.9 5.7 7.7 8.4 7.4 5.4
 659 5.9 5.6 6.8 8.5 8.7 7.9 6.0 5.9 7.3 7.8 6.9 6.0
```

RANGE—Annual or Monthly Ranges (Upper and Lower Bounds) of Expected Climate-Data Values

The example shows monthly expected range for precipitation on days of that month, in inches, starting with January (column 1) and ending with December (column 12). The comment line is noted as //. Data row 1 holds minimum expected values. Data row 2 holds maximum expected values.

Example file, **MERCED_PPT_RANGE**

```
// MIN MAX
 0 0 0 0 0 0 0 0 0 0 0 0
14 14 14 14 8 5 5 5 7 9 12 14
```

STA_AVERAGES—Climate-Station Location Mean-Monthly Parameter-Elevation Regressions on Independent Slopes Model Values

The example shows precipitation values in inches for 15 stations. Pound signs demarcate the header above and data below. Column 1 lists the climate-station identification in sequential order. This is the same order as is found in the LOCATIONS file (example file, MERCED_PPT_LOCATIONS). Columns 2–13 hold monthly values starting with January (column 2) and ending with December (column 13).

Example file, **MERCED_PPT_STA_AVERAGES**

```
Merced PRISM PPT 1981-2010 30-year mean-monthly totals. Units = inches.
STA_ID DCC DUC DDL FA6724EE 42920 C148 44113 MBB EXC 44115 48380 FA673798 YYV YOW
49855
################################
 1 4.17 3.12 3.5 1.61 0.77 0.19 0.02 0.03 0.39 1.04 2.08 2.91
 2 7.76 6.76 6.2 2.93 1.4 0.55 0.11 0.08 0.39 2.36 4.11 6.09
 3 7.6 6.64 6.09 2.92 1.41 0.5 0.1 0.07 0.41 2.24 4 6.01
 4 7.13 6.72 6.02 2.85 1.58 0.51 0.11 0.07 0.53 2.27 3.97 5.9
 5 4.18 3.52 3.64 1.69 0.75 0.21 0.02 0.03 0.31 1.23 2.3 3.22
 6 2.56 2.32 2.15 1.03 0.52 0.1 0.02 0.03 0.19 0.74 1.31 2
 7 6.33 5.58 5.21 2.46 1.2 0.37 0.06 0.06 0.4 1.86 3.4 5.09
 8 6.12 5.53 5.08 2.4 1.13 0.34 0.06 0.05 0.43 1.85 3.36 5.03
 9 4.18 3.51 3.63 1.69 0.75 0.21 0.03 0.03 0.32 1.23 2.29 3.21
 10 7.49 6.77 6.13 3.02 1.47 0.48 0.09 0.06 0.49 2.33 4.17 6.39
 11 8.35 7.84 6.62 3.39 1.97 0.51 0.2 0.16 0.67 2.98 4.8 6.11
 12 7.77 7.79 6.69 3.2 1.85 0.5 0.2 0.12 0.62 2.77 4.47 6.18
 13 7.3 7.4 6.48 3.2 1.8 0.74 0.56 0.14 0.68 2.34 4.62 6.65
 14 8.35 7.84 6.62 3.39 1.97 0.51 0.2 0.16 0.67 2.98 4.8 6.11
 15 7.3 7.4 6.48 3.2 1.8 0.74 0.56 0.14 0.68 2.34 4.62 6.65
```

STA_PRISM_SIGMA—Climate-Station Location Standard Deviations from Daily Parameter-Elevation Regressions on Independent Slopes Model Temperature Values

The example shows standard deviation of temperature values in degrees Fahrenheit for 17 stations. Pound signs demarcate the header above and data below. Column 1 lists the climate-station identification in sequential order. This is the same order as is found in the PRISM_SIGMA (example file, MERCED_TMAX_PRISM_SIGMA). Columns 2–13 hold monthly values starting with January (column 2) and ending with December (column 13).

Example file, **MERCED_TMIN_STA_PRISM_SIGMA**

```
Mean Monthly Standard Deviation of Daily PRISM values at each location
########
 1 7.0 6.9 6.5 6.8 7.2 6.4 5.1 4.9 6.3 7.0 7.4 7.2
 2 7.2 7.1 6.7 6.9 7.3 6.4 5.2 4.9 6.4 7.1 7.5 7.3
 3 6.0 6.0 5.6 5.9 6.3 5.7 5.0 4.4 5.8 6.1 6.2 6.3
 4 5.9 6.0 5.5 5.9 6.3 5.7 4.9 4.3 5.7 6.0 6.1 6.2
 5 5.3 5.2 4.8 5.0 5.6 5.1 5.0 4.4 5.0 5.2 5.3 5.7
 6 7.1 7.1 6.6 6.8 7.2 6.4 5.1 4.8 6.3 7.0 7.5 7.3
 7 6.4 6.3 5.8 6.0 6.6 6.0 5.2 5.0 6.2 6.5 6.8 6.7
 8 5.7 5.5 4.6 4.7 5.1 4.6 4.7 4.1 4.4 4.8 5.4 6.0
 9 5.5 5.7 5.3 5.7 6.1 5.5 4.9 4.3 5.5 5.8 5.8 5.9
 10 5.4 5.5 5.2 5.5 6.1 5.5 4.9 4.4 5.5 5.7 5.7 5.8
 11 5.3 5.2 4.8 5.0 5.6 5.1 5.0 4.4 5.0 5.2 5.3 5.7
 12 7.4 7.3 6.8 6.9 7.2 6.4 5.3 5.0 6.4 7.0 7.7 7.7
 13 5.9 6.0 5.5 5.9 6.2 5.6 5.0 4.3 5.7 6.0 6.1 6.3
 14 6.1 6.0 5.6 5.8 6.5 5.9 5.1 4.9 6.1 6.4 6.5 6.5
 15 7.8 7.8 7.1 7.1 7.1 6.3 5.3 4.7 6.2 6.8 7.9 8.1
 16 6.1 5.9 5.5 5.7 6.4 5.7 5.0 4.6 5.8 6.2 6.4 6.4
 17 6.1 6.0 5.6 5.8 6.5 5.9 5.1 4.9 6.1 6.4 6.5 6.5
```

References Cited

Daly, C., Neilson, R.P., and Phillips, D.L., 1994, A statistical-topographic model for mapping climatological precipitation over mountainous terrain: Journal of Applied Meteorology, v. 33, p. 140–158, http://www.prism.oregonstate.edu/documents/pubs/1994jappclim_mountainPrecip_gibson.pdf.

Di Luzio, M., Johnson, G.L., Daly, C., Eischeid, J.K., and Arnold, J.G., 2008, Constructing retrospective gridded daily precipitation and temperature datasets for the conterminous United States: Journal of Applied Meteorology and Climatology, v. 47, p. 475–497, http://www.prism.oregonstate.edu/documents/pubs/2008jappclim_retrospectiveDaily_diluzio.pdf.

Appendix 6. Mathematical Theory of Draper Methods I and II

A normalization period is required for Draper Methods I and II and is explained below (see section "Step II—Draper Methods I and II Calculation of Long-Term Daily Normal"). The mathematical processes of generating a daily regression plane used in Methods I and II and distributing daily precipitation or temperatures to modeling mapping units using Draper Method I are explained below (where three or more stations are reporting climate-data measurements on a day of interest). In this discussion the modeling mapping units are Precipitation-Runoff Modeling System (PRMS) Hydrologic Response Units (HRUs).

Step I—Normalization Data Period-of-Record Options

Draper defaults to using a 100-year moving average to compute the normalized observations. This allows flexibility to capture different climate variations that may occur in a 100-year period. This smooths the climate bias associated with using the 30-year mean-monthly PRISM surface. This is an approach used in other climate-distribution methods, such as Lauren Hay's XYZ (Hay and others, 2000; Hay and Clark, 2003; Markstrom and others, 2015). With each new day, the moving temporal window adjusts for varied climate events.

Alternately, a fixed period-of-record may be set for the normalization period, but this introduces limitations. This period of record is locked to a specific temporal snapshot and results are biased to climatic events of that period. Draper operates only on active stations in the fixed period. New stations reporting outside the fixed period will not be used in long-term normal computations.

Step II—Draper Methods I and II Calculation of Long-Term Daily Normal

Precipitation

For each day, each climate-station measurement is normalized by calculating a ratio with the long-term daily mean for that station and month of the year. The result, multiplied by 100, represents the percentage of the long-term daily normal.

$$ObsPrecipNorm = \left(\frac{ObsDay}{ObsMean}\right) \tag{6–1}$$

where

$ObsPrecipNorm$ = normalized precipitation observation,
$ObsDay$ = climate-data measurement, and
$ObsMean$ = mean of all observations in the month of interest of the normalization period.

Temperature

Dividing by the mean is a simple way to normalize precipitation; however, daily high or low temperatures don't always yield a meaningful regression when normalized with that method. Better results are obtained by using the normalization method for creating a statistical standard score, or z-score (Kreyszig, 1979). For each day, each climate-station measurement is centered on the long-term daily mean and divided by the standard deviation for that station and month of the year. The result is the standardized departure from the long-term daily normal.

$$ObsTempNorm = \left(\frac{ObsDay - ObsMean}{ObsStdD} \right) \qquad (6\text{–}2)$$

where

ObsTempNorm = normalized temperature observation,
ObsDay = climate-data measurement,
ObsMean = mean of all observations in the month of interest of the normalization period, and
ObsStdD = standard deviation of all monthly station measurements in the normalization period of record.

Step III—Draper Method I Regression Plane Made from the Normalized Observations

Linear regression is used to determine the slope and intercept of a flat, tilted plane through the normalized observations. The plane represents the trend of that day's observations across the model area. The plane is sampled at each HRU centroid. The regression was performed by computing a least squares fit. Specifically, (ε) in equation 3 was minimized using an LU decomposition method (Press and Flannery, 1992; Borse, 1997). No special weighting was used.

$$\sum_{i=1}^{I} \left[z_i - \left(ax_i + by_i + c \right) \right]^2 = \varepsilon^2 \qquad (6\text{–}3)$$

where

i = index of the station,
I = number of stations,
a = slope of the plane in the x-direction,
b = slope of the plane in the y-direction,
c = z-intercept of the plane,
x = x-coordinate (longitude) of the station,
y = y-coordinate (latitude) of the station,
z = observed value at the station location, and
ε = error between observed values and the plane.

$$HRUz = a * HRUx + b * HRUy + c \qquad (6\text{–}4)$$

where

a = slope of the plane in the x-direction,
b = slope of the plane in the y-direction,
c = z-intercept of the plane,
HRUx = x-coordinate (longitude) of the HRU,
HRUy = y-coordinate (latitude) of the HRU, and
HRUz = value of the regression plane at the HRU centroid.

Step IV—Draper Method I Daily Climate-Data Output

For both temperature and precipitation, daily climate data are calculated at HRU centroids and printed to PRMS formatted files.

$$HRUppt = (HRUz)(PRISMmeanMonthly) \tag{6–5a}$$

or

$$HRUtmp = (HRUz)(PRISMStdD) + (PRISMmeanMonthly) \tag{6–5b}$$

where

HRUz	= Value of the regression plane at the HRU centroid (from equation 6–4),
HRUppt	= Daily precipitation simulation at HRU centroid,
HRUtmp	= Daily temperature simulation at HRU centroid,
PRISMStdD	= Standard deviation of the PRISM data, and
PRISMmeanMonthly	= Mean-monthly PRISM value for an HRU area.

References Cited

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Kreyszig, E., 1979, Advanced engineering mathematics (4th ed.): New York, John Wiley, p. 880.

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Appendix 7. Output File Examples

Also see the main-body section "Output Files" and table 2. The included example output files for individual data types are listed below.

1. Draper climate-data output file for one data type (for example, daily precipitation)
2. Draper log
3. Draper diagnostic spreadsheet
4. Differences between measured values and Draper calculated values at station locations are below: nodata = NaN
5. Header information from DraperManager_debug.bat
6. DraperManager Diff File

Climate-Data Output File in Precipitation-Runoff Modeling System Format—Daily Precipitation

Recall that climate-data output files are formatted for use as input files to the Precipitation-runoff Modeling System (PRMS). The example below shows the Merced River Basin PRMS "climate_hru" file for precipitation data, truncated to list part of the 659 values per row. In each row, columns 1–6 hold the date stamp representing year, month, day, hour, minute, and second. The subsequent columns hold values in sequential order from 1 to the maximum hydrologic response unit (HRU) number. In this example for Merced River Basin PRMS, there are 659 HRUs. The climate-data variable reported in this file is precipitation (precip). For an explanation of PRMS input-file format, see the PRMS-IV manual (Markstrom and others, 2015).

```
DRAPER RESULTS for 659 HRUS, from (PPT stations)
// Using Merced PRISM PPT 1981-2010 30-year mean-monthly totals. Units = inches.
// Units = inches
//
// ———————————————————————
// DRAPER revision 20150722
// Run executed at 09/30/2015 18:41:31
// Input read from MERCED/PPT as monthly totals
// Total Period of Record: 10/1/1948-9/30/2013
// Normalizing Period of Record: 10/1/1948-9/30/2013
// Bounds for values:
// JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
// 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
// 14.0 14.0 14.0 14.0 8.0 5.0 5.0 5.0 7.0 9.0 12.0 14.0
precip 659
################################################################
1948 10 1 0 0 0 0.0 0.0 0.0 … 0.0 0.0 0.0
1948 10 2 0 0 0 0.0 0.0 0.0 … 0.0 0.0 0.0
…
2013 9 29 0 0 0 0.0 0.0 0.0 … 0.0 0.0 0.0
2013 9 30 0 0 0 0.0 0.0 0.0 … 0.0 0.0 0.0
```

Log File

```
Normalizing Period of Record: 10/1/1948-9/30/2013
POR Start = 0, POR End = 23741
WARNING: Switching to averaging method because regression plane produced out of
range value ( 15.4) on 12/23/1955
WARNING: Switching to PRISM mean because averaging method produced out of range
value ( 14.1) on 12/23/1955
WARNING: Switching to averaging method because regression plane produced out of
range value ( 8.2) on 09/18/1959

Calculating mean monthly differences...

DRAPER run completed
```

Differences Between Measured Values and Draper Calculated Values at Station Locations

Overall differences are shown at the beginning of the file and use the following format:

```
Mean monthly differences between station input and calculated values at station
locations:
STA OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP ALL
 1 0.01 0.02 0.01 0.03 0.02 0.03 0.01 0.01 0.00 0.00 0.01 0.00 0.01
 2 0.02 0.03 0.03 0.04 0.05 0.03 0.02 0.01 0.01 0.00 0.00 0.01 0.02
 3 0.01 0.02 0.03 0.03 0.03 0.02 0.02 0.01 0.00 0.00 0.00 0.00 0.02
 4 0.02 0.02 0.03 0.03 0.03 0.03 0.01 0.01 0.00 0.00 0.00 0.01 0.02
 5 0.01 0.01 0.01 0.02 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.01
 6 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00
 7 0.02 0.02 0.06 0.08 0.04 0.03 0.02 0.01 0.01 0.00 0.00 0.00 0.03
 8 0.02 0.02 0.03 0.03 0.04 0.03 0.02 0.01 0.00 0.00 0.00 0.01 0.02
 9 NaN NaN NaN NaN NaN NaN NaN NaN NaN NaN NaN NaN NaN
 10 0.01 0.02 0.04 0.04 0.04 0.04 0.01 0.00 0.00 0.00 0.00 0.00 0.01
 11 0.02 0.01 0.02 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.01
 12 0.01 0.02 0.05 0.04 0.06 0.04 0.02 0.01 0.00 0.00 0.00 0.01 0.02
 13 0.01 0.03 0.05 0.04 0.04 0.03 0.02 0.01 0.01 0.01 0.00 0.01 0.02
 14 0.02 0.02 0.07 0.04 0.03 0.03 0.02 0.01 0.00 0.00 0.00 0.01 0.02
 15 0.01 0.01 0.02 0.02 0.03 0.02 0.01 0.01 0.00 0.00 0.00 0.00 0.01
ALL 0.01 0.01 0.02 0.02 0.03 0.02 0.01 0.01 0.00 0.00 0.00 0.00 0.01
```

Each year's differences are then written, using the following format:

```
Monthly mean differences between station input and calculated values at station
locations:
1949:
STA OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP ALL
 3 0.02 0.00 0.03 0.01 0.05 0.03 0.00 0.01 0.00 0.00 0.00 0.00 0.01
 11 0.02 0.00 0.02 0.01 0.00 0.01 0.00 0.02 0.00 0.00 0.00 0.00 0.01
 15 0.01 0.00 0.02 0.01 0.04 0.06 0.00 0.02 0.00 0.00 0.00 0.00 0.01
ALL 0.02 0.00 0.03 0.01 0.03 0.04 0.00 0.01 0.00 0.00 0.00 0.00 0.01
```

Diagnostic Spreadsheet

Draper writes information to a diagnostic spreadsheet, in comma separated values (*.csv) format, with a filename ending in "_DIAG.csv" (fig. 19). The records are ordered initially by date.

The column names and descriptions are below.

Date - Date in month/day/year.

Num Stations - The number of stations reporting measurements for a day.

Meas Min - The lowest measured value for a day.

Meas Mean - The mean of all measured values for a day.

Meas Max - The highest measured value for a day.

Station Spread - The diagonal corner-to-corner distance of a virtual rectangle surrounding the stations providing measured data for the day divided by the diagonal corner-to-corner distance of the virtual rectangle surrounding all HRU centroids. This gives an indication of how far apart the stations were when determining the regression plane.

Slope - The rise-over-run of the regression plane across the model area. The denominator is the diagonal corner-to-corner distance of a virtual box surrounding all HRU centroids. The variation of the slope across the model area is a combination of the denominator and the variation in Parameter-elevation Regressions on Independent Slopes Model (PRISM) mean-monthly values.

PRISM Min - The minimum of PRISM mean-monthly values for that day.

PRISM Mean - The mean of PRISM mean-monthly values for that day.

PRISM Max - The maximum of PRISM mean-monthly values for that day.

Draper Min - The lowest HRU value computed by Draper for a day, before any adjustments to stay within preset bounds.

Draper Mean - The mean of all unadjusted HRU values computed by Draper for a day.

Draper Max - The highest HRU value computed by Draper for a day, before any adjustments to stay within preset bounds.

Bounds Min - The lowest allowable station measurement or computed HRU value for a day. Draper quits and sends an error message if a measured value, read as input to Draper, is below this threshold. The HRU values computed by Draper that are below this threshold are reset to the minimum bounds value.

Bounds Max - The highest allowable station measurement or computed HRU value for a day. Draper quits and sends an error message if a measured value, read as input to Draper, is above this threshold. The HRU values computed by Draper that are above this threshold are reset to the maximum bounds value.

% Min Used - The percent of the range between the daily minimum measurement (Meas Min) and the Bounds Min reached by the minimum HRU value computed by Draper for a day (Draper Min). A negative percent indicates the lowest HRU value computed by Draper was higher than the lowest measured value for that day (Meas Min). A number above 100 percent indicates that the lowest HRU value computed by Draper was below the allowable minimum bounds (Bound Min). This number should be ignored for precipitation because Meas Min and Bound Min are both zero.

% Max Used - The percent of the range between the daily maximum measurement (Meas Max) and the Bounds Max reached by the maximum value computed by Draper for a day (Draper Max). A negative number indicates the highest HRU value computed by Draper was lower than the highest measurement value. A number above 100 percent indicates the highest HRU value computed by Draper was above the allowable maximum bounds (Bounds Max).

HRU *n* - The value at the HRU number specified by the -hruDiagNum command line option. The default is HRU 1.

Min HRU - The number of HRU values computed by Draper in a day that were below the minimum bounds and reset to the minimum bounds.

Max HRU - The number of HRU values computed by Draper in a day that exceeded the maximum bounds and reset to the maximum bounds.

```
Date, Num Stations, Meas Min, Meas Mean, Meas Max, Station Spread, Slope, PRISM Min,
PRISM Mean, PRISM Max, Draper Min, Draper Mean, Draper Max, Bounds Min, Bounds Max, %
Min Used, % Max Used, HRU 1, Min HRU, Max HRU
1980-04-01, 2, 48.00, 59.00, 70.00, 0.05, 0.00, 37.13, 53.95, 73.24, 32.13, 48.85,
68.94, -97.00, 150.00, 10.95, -1.32, 42.45, 56, 659
```

Header Information from DraperManager_debug.bat

The header output that follows is an example of the climate-data output file produced by invoking DraperManager_debug.bat. Output is formatted for use in Merced River Basin PRMS.

```
DRAPER RESULTS for 659 HRUS, from (TMAX stations)
// Using Mean Monthly Standard Deviation of Daily PRISM values at each location
// Units = degrees F
//
// ─────────────────────
// DRAPER revision 20150722
// Run executed at 05/31/2017 14:00:43
// Input read from MERCED/TMAX as monthly averages
// Total Period of Record: 10/1/1948-9/30/2013
// Normalizing Period of Record: 10/1/1948-9/30/2013
// Bounds for values:
//    JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC
//    0.0   0.0  10.0  10.0  15.0  20.0  20.0  20.0  20.0  10.0   0.0   0.0
//   90.0 100.0 105.0 110.0 115.0 120.0 120.0 120.0 115.0 110.0 100.0  90.0
//        1
// Mean-daily value for each month at each station during normalizing period:
//         1    47.6   47.1   53.7   52.3    NaN   57.1   43.1   50.2   56.0   56.3 …
//         2    47.2   48.5   55.3   55.9    NaN   63.1   42.1   49.7   61.1   58.4 …
//         3    49.7   50.7   61.6   57.1    NaN   67.5   46.0   51.2   66.8   62.7 …
//         4    50.5   53.0   64.4   63.1    NaN   73.4   49.9   56.4   71.5   67.9 …
//         5    59.4   60.8   75.5   71.1    NaN   83.0   56.6   64.2   81.1   77.2 …
//         6    66.8   68.4   84.2   80.9    NaN   90.8   65.8   74.4   88.2   84.9 …
//         7    74.6   77.6   92.9   90.5    NaN   97.3   73.9   82.1   93.6   92.3 …
//         8    75.4   75.9   91.9   89.2    NaN   95.9   73.1   82.0   92.4   93.6 …
//         9    69.8   71.2   87.2   83.6    NaN   90.6   67.5   76.6   88.6   87.7 …
//        10    61.7   60.3   73.4   73.4    NaN   81.0   56.9   66.4   78.0   76.5 …
//        11    51.8   54.6   59.7   62.0    NaN   66.3   47.1   56.4   65.3   64.3 …
//        12    47.5   44.5   49.8   53.9    NaN   56.8   41.6   50.1   56.4   56.1 …
// Count of valid measurements for each month at each station during normalizing
period:
//         1     375    148    396    806      0   1139    553    513    408    173 …
//         2     327    134    362    678      0   1076    552    462    423    165 …
//         3     385    154    372    800      0   1203    552    491    465    179 …
//         4     339    149    360    781      0   1167    626    507    449    178 …
//         5     392    154    371    758      0   1209    621    536    460    184 …
//         6     375    131    360    766      0   1169    609    518    442    177 …
//         7     414    124    372    788      0   1209    557    527    443    184 …
//         8     456    101    366    756      0   1240    662    576    460    186 …
//         9     442    119    330    744      0   1200    547    586    448    177 …
//        10     454    155    328    799      0   1205    589    629    431    202 …
//        11     451    149    353    730      0   1158    599    602    410    199 …
//        12     414    146    363    723      0   1165    549    543    403    183 …
// Min of input measurements for each station during normalizing period:
//        13   20.00  23.00  34.00  30.00 ******  34.00  16.00  23.00  32.00  35.00 …
// Max of input measurements for each station during normalizing period:
```

```
//         13   91.00  90.00 105.00 106.00 ****** 113.00  88.00  99.00 109.00 107.00 …
// Min of input measurements for each station during total period:
//         13   20.00  23.00  34.00  30.00 ******  34.00  16.00  23.00  32.00  35.00 …
// Max of input measurements for each station during total period:
//         13   91.00  90.00 105.00 106.00 ****** 113.00  88.00  99.00 109.00 107.00 …
tmax    659
################################################################
```

DraperManager Diff File

```
DRAPER DIFFERENCES with previous run
(Identical lines omitted)
Number of values that differed = 6 of 15613682
Mean of absolute values of differences = 2.3333333333333335
Maximum difference = 0.0 at , column 0
################################################################
2013 9 15 0 0 0 0.0 -3.0 -3.0 -3.0 0.0 0.0 0.0
2013 9 16 0 0 0 0.0 0.0 -2.0 -2.0 0.0 0.0 0.0
2013 9 17 0 0 0 0.0 0.0 0.0 -1.0 0.0 0.0 0.0
```

References Cited

Markstrom, S.L., Regan, R.S., Hay, L.E., Viger, R.J., Webb, R.M.T., Payne, R.A., and LaFontaine, J.H., 2015, PRMS-IV, the precipitation-runoff modeling system, version 4: U.S. Geological Survey Techniques and Methods, book 6, chap. B7, 158 p., accessed December 7, 2018, at https://doi.org/10.3133/tm6B7.

Appendix 8. Tips on Changing Included Example Draper Input Files to get Different Results

1. To change the normalization period, edit the file named "MERCED_NORM_POR." Rerun Draper.
2. To change upper and lower bounds of expected results, edit the files named "MERCED_PPT_RANGE, MERCED_TMAX_RANGE, MERCED_TMIN_RANGE."
3. To add new records to the output files, daily measurements must first be added to data files named "MERCED_MEAS_PPT.data, MERCED_MEAS_TMAX.data, or MERCED_MEAS_TMIN.data." Rerun Draper.
4. In the measured-data file, use –99 to denote missing data values, not "0." Zero is seen by Draper as a real measurement, and the station will be considered "active" for that day. A zero measurement will be used in the Draper computations. This will bias results towards erroneously low station averages and simulate false climatic events.
5. Make sure measured data are free of extreme, erroneous values (for example, if 1 day of precipitation = 59 inches). These measurements will bias the Draper computations and simulate false events (in this case, a false storm event for that day). See section "Evaluating and Improving Results" for tools to aid Quality Assurance/Quality Control of datasets.

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